Harimohan Ghose College
Department of Mathematics
B.Sc. Semester 1 (Major under CCF)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
MATH-H-CC1-1-Th	Calculus, Geometry & Vector Analysis	**Group A:** Calculus: Differentiability of a function, meaning of sign of derivative, differentiating hyperbolic functions, higher order derivatives, Leibnitz rule and its applications, indeterminate forms. L'Hospital's rule. Reduction formulae, derivations and illustrations of reduction formulae, parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.	Shubhankar Podder
		Group B: Geometry: Rotation of axes and second degree equations, classification of conics using the discriminant, reduction to canonical form, tangent and normal, polar equations of conics. Spheres, cylindrical surfaces, central conicoids, paraboloids, plane sections of conicoids, generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.	Arkopriya Mallick
		Group C: Vector Analysis: Triple product, vector equations, applications to geometry and mechanics - concurrent forces in a plane, theory of couples, system of parallel forces. Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable.	Subhadipa Das

MATH-H-SEC1-1-Th	C Language with Mathematical Applications	Overview of architecture of computer, compiler, assembler, machine language, high level language, object-oriented language, programming language and importance of C programming. Constants, Variables and Data type of C-Program: character set, constants and variables data types, expression, assignment statements, declaration. Operation and Expressions: arithmetic operators, relational operators, logical operators. Decision Making and Branching: decision making with if statement, if-else statement, nesting if statement, switch statement, break and continue statement. Control Statements: while statement, do-while statement, for statement. Arrays: one-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays. User-defined Functions: definition of functions, scope of variables, return values and their types, function declaration, function call by value, nesting of functions, passing of arrays to functions, recurrence of function. Introduction to library functions.	Ratan Jana

B.Sc. Semester 1 (Minor under CCF)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
MATH-MD-CC1-1-Th	Calculus, Geometry & Vector Analysis	**Group A:** Calculus: Differentiability of a function, meaning of sign of derivative, differentiating hyperbolic functions, higher order derivatives, Leibnitz rule and its applications, indeterminate forms. L'Hospital's rule. Reduction formulae, derivations and illustrations of reduction formulae, parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.	Shubhankar Podder
		Group B: Geometry: Rotation of axes and second degree equations, classification of conics using the discriminant, reduction to canonical form, tangent and normal, polar equations of conics. Spheres, cylindrical surfaces, central conicoids, paraboloids, plane sections of conicoids, generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.	Arkopriya Mallick
		Group C: Vector Analysis: Triple product, vector equations, applications to geometry and mechanics - concurrent forces in a plane, theory of couples, system of parallel forces. Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable.	Subhadipa Das

MATH-MD-SEC1-1-Th	C Language with Mathematical Applications	Overview of architecture of computer, compiler, assembler, machine language, high level language, object-oriented language, programming language and importance of C programming. Constants, Variables and Data type of C-Program: character set, constants and variables data types, expression, assignment statements, declaration. Operation and Expressions: arithmetic operators, relational operators, logical operators. Decision Making and Branching: decision making with if statement, if-else statement, nesting if statement, switch statement, break and continue statement. Control Statements: while statement, do-while statement, for statement. Arrays: one-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays. User-defined Functions: definition of functions, scope of variables, return values and their types, function declaration, function call by value, nesting of functions, passing of arrays to functions, recurrence of function. Introduction to library functions.	Ratan Jana

B.Sc. Semester 3 (Honours under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
CC-5	Theory of Real Functions	**Unit-1:** Limits of functions, sequential criterion for limits, infinite limits and limits at infinity. Continuity of a function on an interval and at an isolated point, sequential criteria for continuity, concept of oscillation of a function at a point, bounded functions, neighbourhood properties of continuous functions regarding boundedness and maintenance of same sign, intermediate value theorem, discontinuity of functions, type of discontinuity, step functions, piecewise continuity, monotone functions. Uniform continuity, Lipschitz condition and uniform continuity.	Subhadipa Das
		Unit-2: Differentiability of a function at a point and in an interval, meaning of sign of derivative, chain rule, Darboux theorem, Rolle's theorem, Mean value theorems of Lagrange and Cauchy, Taylor's theorem on closed and bounded interval with Lagrange's and Cauchy's form of remainder deduced from Lagrange's and Cauchy's mean value theorem respectively, statement of L' Hospital's rule and its consequences, point of local extremum of a function in an interval, sufficient condition for the existence of a local maximum/minimum of a function at a point, determination of local extremum using first order derivative, application of the principle of maximum/minimum.	

CC-6	Ring Theory & Linear Algebra-I	**Unit-1:** Definition and examples of rings, properties of rings, subrings, integral domains and fields, subfield, characteristic of a ring, ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals. Ring homomorphisms, properties of ring homomorphisms. first isomorphism theorem, second isomorphism theorem, third isomorphism theorem, correspondence theorem, congruence on rings, one-one correspondence between the set of ideals and the set of all congruences on a ring.	Shubhankar Podder
		Unit-2 Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, change of coordinate matrix, isomorphisms, isomorphism theorems, invertibility and isomorphisms. Eigen values, eigen vectors and characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding the inverse of a matrix.	
CC-7	Ordinary Differential Equation & Multivariate Calculus-I	**Unit-1:** Ordinary Differential Equation: First order differential equations, exact differential equations and integrating factors, special integrating factors and transformations, linear equations and Bernoulli equations, the existence and uniqueness theorem of Picard. Linear equations and equations reducible to linear form. First order higher degree equations solvable for x, y and p, Clairaut's equations and singular solution. Basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients. Linear differential equations of second order, Wronskian: its properties and applications, Euler equation, method of undetermined coefficients, method of variation of parameters. System of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Planar linear autonomous systems: Equilibrium (critical) points, Interpretation of the phase plane and phase portraits. Power series	Arkopriya Mallick

		solution of a differential equation about an ordinary point, solution about a regular singular point.	
		Unit-2: Multivariate Calculus-I: Concept of neighbourhood of a point in $\mathbb{R}^n$ $(n > 1)$, interior point, limit point, open set and closed set in $\mathbb{R}^n$ $(n > 1)$. Functions from $\mathbb{R}^n$ $(n > 1)$ to $\mathbb{R}^m$ $(m \geq 1)$, limit and continuity of functions of two or more variables. Partial derivatives, total derivative and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes. Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.	
SEC A	C Programming Language	An overview of theoretical computers, history of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object-oriented language, programming language and importance of C programming. Constants, Variables and Data type of C-Program: character set, constants and variables data types, expression, assignment statements, declaration. Operation and Expressions: arithmetic operators, relational operators, logical operators. Decision Making and Branching: decision making with if statement, if-else statement, nesting if statement, switch statement, break and continue statement. Control Statements: while statement, do-while statement, for statement. Arrays: one-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays. User-defined Functions: definition of functions, scope of variables, return values and their types, function declaration, function call by value, nesting of functions, passing of arrays to functions, recurrence of function. Introduction to library functions.	Ratan Jana

B.Sc. Semester 3 (General under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
GE-3	Mathematics GE-3	**Unit-1:** Integral Calculus: Evaluation of definite integrals, integration as the limit of a sum, reduction formulae. Improper Integrals: μ-test, comparison test, Beta and Gamma functions	Shubhankar Podder
		Unit-2: Numerical Methods: Approximate numbers, significant figures, rounding off numbers. Error: absolute, relative and percentage. Δ, ∇ and E operators. Interpolation, deduction of Newton's forward and backward interpolation formula with remainder term, Lagrange's interpolation. Trapezoidal and Simpson's $\frac{1}{3}$-rd formula. To find a real root of an algebraic or transcendental equation, location of root (tabular method), bisection method, Newton-Raphson method.	Arkopriya Mallick
		Unit-3: Linear Programming: Linear Programming problem, formulation of L.P.P. slack and surplus variables, L.P.P. is matrix form, convex set, hyperplane, extreme points, convex polyhedron, basic solutions and Basic Feasible Solutions (B.F.S.). Fundamental Theorem of L.P.P., reduction of a feasible solution to a B.F.S., standard form of an L.P.P. solution by graphical method, by simplex method and method of penalty. Concept of duality, duality theory, transportation and Assignment problem and their optimal solutions.	Subhadipa Das

SEC-A	C Programming Language	An overview of theoretical computers, history of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object-oriented language, programming language and importance of C programming. Constants, variables and data type of C-Program: character set. Constants and variables data types, expression, assignment statements, declaration. Operation and Expressions: arithmetic operators, relational operators, logical operators. Decision Making and Branching: decision making with if statement, if-else statement, nesting if statement, switch statement, break and continue statement. Control Statements: while statement, do-while statement, for statement. Arrays: one-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays. User-defined Functions: functions, scope of variables, return values and their types, function declaration, function call by value, nesting of functions, passing of arrays to functions, recurrence of function. Introduction to Library functions.	Ratan Jana

B.Sc. Semester 5 (Honours under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
CC-11	Probability & Statistics	**Unit-1:** Random experiment, σ-field, sample space, probability as a set function, probability axioms, probability space. finite sample spaces. conditional probability, Bayes theorem, independence, real random variables, cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.	Arkopriya Mallick
		Unit-2: Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, moments, covariance, correlation coefficient, independent random variables, joint moment generating function (jmgf) and calculation of covariance from jmgf, characteristic function, conditional expectations, linear regression for two variables, regression curves. Bivariate normal distribution.	
		Unit-3: Markov and Chebyshev's inequality, convergence in probability, statement and interpretation of weak law of large numbers and strong law of	

		large numbers, central limit theorem for independent and identically distributed random variables with finite variance.	
		Unit-4: Sampling and sampling distributions, Estimation of parameters, method of maximum likelihood.	
		Unit-5: Statistical hypothesis, simple hypothesis versus simple alternative, bivariate frequency distribution.	
CC-12	Group Theory-II & Linear Algebra-II	**Unit-1:** Group Theory: Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. External direct product and its properties, the group of units modulo n as an external direct product, internal direct product, converse of Lagrange's theorem for finite abelian group, Cauchy's theorem for finite abelian group, Fundamental theorem of finite abelian groups.	Shubhankar Podder
		Unit-2: Linear Algebra: Inner product spaces and norms, Gram-Schmidt orthonormalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator. Bilinear and quadratic forms, diagonalisation of symmetric matrices, second derivative test for critical point of a function of several variables, Hessian matrix, Sylvester's law of inertia, index, signature. Dual spaces, dual basis, double dual, transpose of a linear transformation, annihilators. Eigenspaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms.	
DSE A(1)	Bio Mathematics	**Unit-1:** Mathematical biology and the modelling process, continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, bacterial growth in a chemostat, harvesting a single natural population, Prey predator systems and Lotka-Volterra equations, populations in competitions, epidemic models (SI, SIR, SIRS, SIC).	Ratan Jana

		Unit-2: Activator-inhibitor system, insect outbreak model: Spruce Budworm. Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria. Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario. Spatial models: One species model with diffusion. Two species model with diffusion, conditions for diffusive instability, spreading colonies of microorganisms, Blood flow in circulatory system, travelling wave solutions, spread of genes in a population.	
		Unit-3: Discrete models: overview of difference equations, steady state solution and linear stability analysis. Introduction to discrete models, linear models, growth models, decay models, drug delivery problem, discrete prey-predator models, density dependent growth models with harvesting, host-parasitoid systems (Nicholson- Bailey model), numerical solution of the models and its graphical representation. Optimal exploitation models, models in genetics, stage structure models, age structure models.	
DSE B(1)	Linear Programming & Game Theory	**Unit-1:** Definition of Linear Programming Problem (L.P.P.), formation of L.P.P., graphical solution of L.P.P., basic solutions and Basic Feasible Solution (B.F.S) with reference to L.P.P. Matrix formulation of L.P.P. Degenerate and Non-degenerate B.F.S. Hyperplane, convex set, cone, extreme points, convex hull and convex polyhedron. Supporting and Separating hyperplane. The collection of a feasible solutions of an L.P.P. constitutes a convex set. The extreme points of the convex set of feasible solutions correspond to its B.F.S. and conversely. The objective function has its optimal value at an extreme point of the convex polyhedron generated by the set of feasible solutions. In the absence of degeneracy, if the L.P.P. admits of an optimal solution then at least one B.F.S. must be optimal. Reduction of a F.S. to a B.F.S.	Subhadipa Das

		Unit-2: Slack and surplus variables, standard form of L.P.P. theory of simplex method, feasibility and optimality conditions. The algorithm, two phase method, degeneracy in L.P.P. and its resolution.	
		Unit-3: Duality theory: the dual of dual is the primal, relation between the objective values of dual and the primal problems, relation between their optimal values, complementary slackness, duality and simplex method and their applications.	
		Unit-4: Transportation and assignment problems, mathematical justification for optimality criterion, Hungarian method, traveling salesman problem. Concept of game problem, rectangular games, pure strategy and mixed strategy, saddle point and its existence, optimal strategy and value of the game, necessary and sufficient condition for a given strategy to be optimal in a game, concept of dominance, Fundamental Theorem of rectangular games, algebraic method, graphical method and dominance method of solving rectangular games, inter-relation between theory of games and L.P.P.	

B.Sc. Semester 5 (General under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
DSE-A	Graph Theory	Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs, isomorphism of graphs. Paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm. Definition of trees and their elementary properties. Definition of planar graphs, Kuratowski's graphs.	Ratan Jana

B.Sc. Semester 2 (Major under CCF)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
MATH-H-CC2-2-TH	Basic Algebra	**Group A:** Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications, exponential, logarithmic, trigonometric and hyperbolic functions of complex variable, theory of equations, inequality involving $AM \geq GM \geq HM$, Cauchy-Schwartz inequality.	Subhadipa Das
		Group B: Relation, mapping, well-ordering property of positive integers, principles of mathematical induction, division algorithm, divisibility and Euclidean algorithm, prime numbers and their properties, Euclid's theorem, congruence relation between integers, fundamental theorem of arithmetic, Chinese remainder theorem, arithmetic functions.	Shubhankar Podder
		Group C: Systems of linear equations, homogeneous and non-homogeneous systems, existence and uniqueness of solution, row reduction and echelon forms, uniqueness of reduced echelon form, rank of a matrix and characterization of invertible matrices, pivot positions, basic and free variables, parametric description of the solution set, existence and uniqueness theorem. Vectors in $\mathbb{R}^n$, algebraic and geometric properties of the vectors, vector form	Arkopriya Mallick

		of a linear system and the column picture, existence of solutions and linear combination of vectors, geometry of linear combination and subsets spanned by some vectors, uniqueness of solution and linear independence of vectors, algebraic and geometric characterizations of linearly independent subsets.	
MATH-H-SEC 2.1-2-Th	Python Programming and Introduction to Latex	**Group A:** Python Programming: Python programming language, features, installing python, running code in the interactive shell, IDLE, input, processing and output, editing, saving, and running a script, debugging: syntax errors, runtime errors, semantic errors. Data types and expressions: variables and the assignment statement, program comments and doc strings, data types-numeric integers and floating-point numbers, Boolean string, mathematical operators, PEMDAS, arithmetic expressions, mixed-mode arithmetic and type conversion, type( ), input( ), print( ), program comments, id( ), int( ), str( ), float( ). Loops and selection statements: definite iteration: for loop, executing statements a given number of times, specifying steps using range( ), loops that count down, Boolean and comparison operators and expressions, conditional and alternative statements- chained and nested conditionals: if, if-else, if-else if else, nested if, nested if-else. Compound Boolean expressions, conditional iteration: while loop-with true condition, break statement, random numbers. loop logic, errors and testing. Strings, lists, tuple, dictionary: accessing characters, indexing, slicing, replacing. Concatenation (+), repetition (*), searching a substring with the 'in' operator, traversing string using while and for. String methods-find, join, split, lower, upper. len( ). Lists-accessing and slicing, basic operations (comparison,+), list membership and for loop, replacing element (list is mutable), list methods append, extend, insert, pop, sort. Max( ), min( ), tuples, dictionaries-creating a dictionary, adding keys and replacing values, dictionary - key( ), value( ), get( ), pop( ), traversing a dictionary. Math module: sin(), cos(), exp(), sqrt(), constants-pi, e. Design with functions: defining simple functions-parameters and arguments, the return	Ratan Jana

		statement, tuple as return value, Boolean functions, defining a main function, defining and tracing recursive functions. Working with Numbers: calculating the factors of an integer, generating multiplication tables, con	
		Group B: Introduction to Latex: Introduction to LATEX: preparing a basic LATEX file, compiling LATEX file. Document classes: different type of document classes, e.g., article, report, book etc. Page Layout: titles, abstract, chapters, sections, subsections, paragraph, verbatim, references, equation references, citation. List structures: itemize, enumerate, description etc. Representation of mathematical equations: inline math, equations, fractions, matrices, trigonometric, logarithmic, exponential functions, line, surface, volume integrals with and without limits, closed line integral, surface integrals, scaling of parentheses, brackets etc. Customization of fonts: bold fonts, emphasise, mathbf, mathcal etc, changing sizes large, larger, huge, tiny etc. Writing tables: creating tables with different alignments, placement of horizontal, vertical lines. Figures: changing and placing the figures, alignments Packages: amsmath, amssymb, graphics, graphicx, geometry, algorithms, color, hyperref etc. Use of different LATEX commands and environments, changing the type style, symbols from other languages, special characters.	

B.Sc. Semester 2 (Minor under CCF)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
MATH-MD-CC2-2-TH	Basic Algebra	**Group A:** Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications, exponential, logarithmic, trigonometric and hyperbolic functions of complex variable, theory of equations, inequality involving $AM \geq GM \geq HM$, Cauchy-Schwartz inequality.	Subhadipa Das
		Group B: Relation, mapping, well-ordering property of positive integers, principles of mathematical induction, division algorithm, divisibility and Euclidean algorithm, prime numbers and their properties, Euclid's theorem, congruence relation between integers, fundamental theorem of arithmetic, Chinese remainder theorem, arithmetic functions.	Shubhankar Podder
		Group C: Systems of linear equations, homogeneous and non-homogeneous systems, existence and uniqueness of solution, row reduction and echelon forms, uniqueness of reduced echelon form, rank of a matrix and characterization of invertible matrices, pivot positions, basic and free variables, parametric description of the solution set, existence and uniqueness theorem. Vectors in $\mathbb{R}^n$, algebraic and geometric properties of the vectors, vector form of a linear system and the column picture, existence of solutions and linear combination of vectors, geometry of linear combination and subsets spanned	Arkopriya Mallick

		by some vectors, uniqueness of solution and linear independence of vectors, algebraic and geometric characterizations of linearly independent subsets.	
MATH-MD-SEC 2.1-2-Th	Python Programming and Introduction to Latex	**Group A:** Python Programming: Python programming language, features, installing python, running code in the interactive shell, IDLE, input, processing and output, editing, saving, and running a script, debugging: syntax errors, runtime errors, semantic errors. Data types and expressions: variables and the assignment statement, program comments and doc strings, data types-numeric integers and floating-point numbers, Boolean string, mathematical operators, PEMDAS, arithmetic expressions, mixed-mode arithmetic and type conversion, type( ), input( ), print( ), program comments, id( ), int( ), str( ), float( ). Loops and selection statements: definite iteration: for loop, executing statements a given number of times, specifying steps using range( ), loops that count down, Boolean and comparison operators and expressions, conditional and alternative statements- chained and nested conditionals: if, if-else, if-else if else, nested if, nested if-else. Compound Boolean expressions, conditional iteration: while loop-with true condition, break statement, random numbers. loop logic, errors and testing. Strings, lists, tuple, dictionary: accessing characters, indexing, slicing, replacing. Concatenation (+), repetition (*), searching a substring with the 'in' operator, traversing string using while and for. String methods-find, join, split, lower, upper. len( ). Lists-accessing and slicing, basic operations (comparison,+), list membership and for loop, replacing element (list is mutable), list methods append, extend, insert, pop, sort. Max( ), min( ), tuples, dictionaries-creating a dictionary, adding keys and replacing values , dictionary - key( ), value( ), get( ), pop( ), traversing a dictionary. Math module: sin(), cos(), exp(), sqrt(), constants-pi, e. Design with functions: defining simple functions-parameters and arguments, the return statement, tuple as return value, Boolean functions, defining a main function,	Ratan Jana

		defining and tracing recursive functions. Working with Numbers: calculating the factors of an integer, generating multiplication tables, con	
		Group B: Introduction to Latex: Introduction to LATEX: preparing a basic LATEX file, compiling LATEX file. Document classes: different type of document classes, e.g., article, report, book etc. Page Layout: titles, abstract, chapters, sections, subsections, paragraph, verbatim, references, equation references, citation. List structures: itemize, enumerate, description etc. Representation of mathematical equations: inline math, equations, fractions, matrices, trigonometric, logarithmic, exponential functions, line, surface, volume integrals with and without limits, closed line integral, surface integrals, scaling of parentheses, brackets etc. Customization of fonts: bold fonts, emphasise, mathbf, mathcal etc, changing sizes large, larger, huge, tiny etc. Writing tables: creating tables with different alignments, placement of horizontal, vertical lines. Figures: changing and placing the figures, alignments Packages: amsmath, amssymb, graphics, graphicx, geometry, algorithms, color, hyperref etc. Use of different LATEX commands and environments, changing the type style, symbols from other languages, special characters.	

B.Sc. Semester 4 (Honours under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
CC-8	Riemann Integration & Series of Functions	**Unit-1:** Riemann integration: Partition of a closed and bounded interval, upper Darboux sum and lower Darboux sum, upper integral and lower integral, Darboux's and Riemann's definition of integrability. Concept of negligible set, example of Riemann integrable functions. Integrability of sum, scalar multiple, product, quotient, modulus of Riemann integrable functions. Function defined by definite integral and its properties. Antiderivative, properties of Logarithmic function defined as the definite integral. Fundamental theorem of Integral Calculus, first Mean Value theorem of integral calculus.	Ratan Jana
		Unit-2: Improper Integral: Range of integration, finite or infinite, necessary and sufficient condition for convergence of improper integral in both cases, tests of convergence, convergence and working knowledge of Beta and Gamma function and their interrelation.	
		Unit-3: Series of Functions: Sequence of functions, pointwise and uniform convergence, Cauchy criterion of uniform convergence, Weierstrass' M-test, boundedness, continuity, integrability and differentiability of the limit function of a sequence of functions in case of uniform convergence. Series of functions, pointwise and uniform convergence, Cauchy criterion of uniform convergence, Weierstrass' M-test, boundedness, continuity, integrability, differentiability of a series of functions in case of uniform convergence. Power series, fundamental	

		theorem of power series, Cauchy-Hadamard theorem, determination of radius of convergence, uniform and absolute convergence of power series, differentiation and integration of power series, Abel's limit theorems. Fourier series, trigonometric series, Dirichlet's condition of convergence.	
CC-9	Partial Differential Equation & Multivariate Calculus-II	**Unit-1:** Partial differential equation: Partial differential equations of the first order, Lagrange's solution, non-linear first order partial differential equations, Charpit's general method of solution. Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms. The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of finite and infinite string. Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Equations with non-homogeneous boundary conditions. Non-homogeneous wave equation. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem.	Shubhankar Podder
		Unit-2: Multivariate Calculus-II: Multiple integral, concept of upper sum, lower sum, upper integral, lower-integral and double integral, existence theorem for continuous functions, iterated or repeated integral, change of order of integration, triple integral. Change of variables in double integrals and triple integrals. Transformation of double and triple integrals, determination of volume and surface area by multiple integrals, differentiation under the integral sign, Leibniz's rule. Definition of vector field, divergence and curl. Line integrals, applications of line integrals: mass and work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, the divergence theorem.	
CC-10	Mechanics	**Unit-1:** Coplanar forces in general, an arbitrary force system in space, equilibrium in the presence of sliding Friction force.	Arkopriya Mallick

		Unit-2: Virtual work, stability of equilibrium.	
		Unit-3: Kinematics of a particle, Newton laws of motion and law of gravitation.	
		Unit-4: Problems in particle dynamics, planar motion of a particle, motion of a particle in three dimensions.	
		Unit-5: Many particles system, the linear momentum principle, the angular momentum principle, the energy principle.	
SEC B	Mathematical Logic	**Unit-1:** Propositions, truth table, negation, conjunction and disjunction, implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. General Notions: formal language, object and meta language, general definition of a Formal Theory/Formal Logic.	Subhadipa Das
		Unit-2: Propositional Logic: formal theory for propositional calculus, derivation, proof, theorem, deduction theorem, conjunctive and disjunctive normal forms, semantics, truth tables, tautology, adequate set of connectives, applications to switching circuits, logical consequence, consistency, maximal consistency, Leindenbaum lemma, soundness and completeness theorems, algebraic semantics.	
		Unit-3: Predicate Logic: first order language, symbolizing ordinary sentences into first order formulae, free and bound variables, interpretation and satisfiability, models, logical validity, formal theory for predicate calculus, theorems and derivations, deduction theorem, equivalence theorem, replacement theorem, choice rule, Prenex normal form, soundness theorem, completeness theorem, compactness theorem, first order theory with equality.	

B.Sc. Semester 4 (General under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
GE-4	Mathematics GE-4	**Unit-1:** Algebra-II: Group, subgroup, ring, field, subring, subfield, vector space, linear combinations, linear dependence and independence of a finite number of vectors, subspace, concepts of generators and basis of a finite dimensional vector space, problems on formation of basis of a vector space, real quadratic form involving not more than three variables, characteristic equation of square matrix of order not more than three, determination of eigenvalues and eigenvectors, Cayley-Hamilton Theorem.	Shubhankar Podder
		Unit-2: Computer Science & Programming: Computer Science and Programming: historical development, computer generation, computer anatomy different components of a computer system, operating system, hardware and software. Positional number system, binary to decimal and decimal to binary, other systems, binary arithmetic octal, hexadecimal, etc. Storing of data in a computer - BIT, BYTE, WORD etc. Coding of a data-ASCII, etc. Programming Language: machine language, assembly language and high-level language, compiler and interpreter. Object Programme and source programme. Ideas about some HLL- e.g. BASIC, FORTRAN, C, C++, COBOL, PASCAL, etc. Algorithms and Flow Charts- their utilities and important features, ideas about the complexities of an algorithm. Application in simple problems. FORTRAN	Ratan Jana

		77/90: introduction, data type-keywords, constants and variables - integer, real, complex, logical, character, subscripted variables, FORTRAN expressions.	
		Unit-3: Probability & Statistics: Random experiment, outcome, event, mutually exclusive events, equally likely and exhaustive. Classical definition of probability, theorems of total Probability, conditional probability and statistical independence, Baye's Theorem. Problems, shortcoming of the classical definition, axiomatic approach problems, random variable and its expectation, theorems on mathematical expectation, joint distribution of two random variables. Theoretical probability distribution discrete and continuous (p.m.f., p.d.f.) binomial, poisson and normal distributions and their properties. Elements of statistical methods, variables, attributes. Primary data and secondary data, population and sample. Census and sample survey. Tabulation chart and diagram, graph, bar diagram, pie diagram etc. Frequency distribution un-grouped and grouped cumulative frequency distribution. Histogram, frequency curve, measures of central tendencies. Averages: AM, GM, HM, mean, median and mode. Measures of Dispersions-range, quartile deviation, mean deviation, variance / S.D., moments, skewness and Kurtosis. Sampling Theory: meaning and objects of sampling, some ideas about the methods of selecting samples, statistic and parameter, sampling proportion. Four fundamental distributions, derived from the normal: standard normal distribution, Chi-square distribution, student's distribution, Snedecor's F-distribution. Estimation and test of significance, statistical inference, theory of estimation point estimation and interval estimation, confidence Interval / confidence limit. Statistical Hypothesis - null hypothesis and alternative hypothesis, level of significance, critical region, type I and II error. Bivariate frequency distribution, scatter diagram, co-relation co-efficient, regression lines.	Arkopriya Mallick

B.Sc. Semester 6 (Honours under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
CC-13	Metric Space & Complex Analysis	**Unit-1:** Metric Space: Definition and examples of metric spaces, open ball, open set, closed set, interior point and interior of a set, limit point and closure of a set, boundary point and boundary of a set, bounded set and diameter of a set, distance between two sets, subspace of a metric space. Convergent sequence, Cauchy sequence, completeness, Cantor's intersection theorem. Continuity, uniform continuity. Compactness, sequential compactness, Heine-Borel theorem in $\mathbb{R}$, finite intersection property, continuous functions on compact sets. Concept of connectedness, contraction mappings, Banach Fixed point Theorem and its application to ordinary differential equations.	Shubhankar Podder
		Unit-2: Complex Analysis: Stereographic projection, regions in the complex plane, limits, continuity of functions of complex variable. Derivatives, Cauchy-Riemann equations, sufficient conditions for differentiability, analytic functions, exponential function, logarithmic function, trigonometric functions, hyperbolic functions, Möbius transformation. Power series, Cauchy-Hadamard theorem, radius of convergence, uniform and absolute convergence of power series, analytic functions represented by power series, uniqueness of power series. Contours, complex integration along a contour, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.	

CC-14	Numerical Methods	**Unit-1:** Representation of real numbers, machine Numbers - floating point and fixed point, sources of Errors, rounding of numbers, significant digits and error propagation in machine arithmetic operations. Numerical Algorithms - stability and convergence.	Ratan Jana
		Unit-2: Approximation, interpolation, central interpolation.	
		Unit-3: Numerical differentiation, numerical integration.	
		Unit-4: Bisection method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Condition of convergence (if any), order of convergence, rate of convergence of these methods. Modified Newton-Raphson method for multiple roots, complex roots of an algebraic equation by Newton-Raphson method. Numerical solution of system of nonlinear equations - Newton's method.	
		Unit-5: System of linear algebraic equations, Gauss Jacobi method, Gauss Seidel method and their convergence analysis, LU decomposition method. Matrix inversion, the algebraic eigenvalue problem.	
		Unit-6: Single-step difference equation methods- error, convergence. The method of successive approximations (Picard), Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.	
CC-14 (Practical)	Numerical Methods Lab	1. Calculate the sum $\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\cdots+\frac{1}{N}$.	Ratan Jana
		2. Enter 100 integers into an array and sort them in an ascending order.	
		3. Bisection method, Newton Raphson method (Simple root, multiple roots, complex roots), Secant method, Regula Falsi method.	
		4. LU decomposition method, Gaussian elimination method, Gauss-Jacobi method, Gauss-Seidel method.	
		5. Lagrange Interpolation, Newton's forward, backward and divided difference interpolations.	

		6. Trapezoidal Rule, Simpson's one third Rule, Weddle's Rule, Gauss Quadrature.	
		7. Method of finding eigenvalue by power method (up to 4×4).	
		8. Fitting a polynomial function (up to third degree).	
		9. Euler method, Modified Euler method, Runge Kutta method (order 4), The method of successive approximations (Picard).	
DSE A(2)	Mathematical Modelling	**Unit-1:** Power series solution of Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order.	Ratan Jana
		Unit-2: Monte Carlo simulation modelling: simulating deterministic behavior (area under a curve, volume under a surface), generating random numbers: middle square method, linear congruence, queuing models: harbor system, morning rush hour, overview of optimization modelling. Linear programming model: geometric solution algebraic solution, simplex method, sensitivity analysis	
DSE B(2)	Point Set Topology	**Unit-1:** Topological spaces, basis and subbasis for a topology, neighbourhoods of a point, interior points, limit points, derived set, boundary of a set, closed sets, closure and interior of a set, dense subsets, subspace topology, finite product topology, continuous functions, open maps, closed maps, homeomorphisms, topological invariants, metric topology, isometry and metric invariants.	Subhadipa Das
		Unit-2: First countability, T_1 and T_2 separation axioms of topological spaces, convergence and cluster point of a sequence in topological spaces and some related concepts on first countable as well as on T_2 spaces, Heine's continuity criterion.	
		Unit-3: Connected spaces, connected sets in $\mathbb{R}$, components, compact spaces, compactness and T_2, compact sets in $\mathbb{R}$, Heine-Borel Theorem for	

		$\mathbb{R}^n$, real valued continuous function on connected and compact spaces, the concept of compactness in metric space, sequentially compactness of a metric space X and the Bolzano- Weiertrass property of X are equivalent.	

B.Sc. Semester 6 (General under CBCS)

Lesson Plan 2023-24

Course Code	Course Name	Brief Description of the Course	Name of the Faculty
SEC-B	Boolean Algebra	Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms. Definition, examples and properties of modular and distributive lattices, Boolean algebras. Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and minimization of switching circuits using Boolean algebra.	Subhadipa Das
DSE-B	Advanced Calculus	Pointwise and uniform convergence of sequence of functions and series of functions with special reference of power series, Weierstrass M-Test for uniform convergence of sequence of functions and of series of functions, simple applications, statement of important properties like boundedness, continuity, differentiability and integrability of the limit function of uniformly convergent sequence of functions and of the sum function of uniformly convergent series of functions, radius of convergence of power series, term by term integration and term by term differentiation of power series, Abel's theorems on power series, convergence of power series.	Ratan Jana
		Periodic function, Fourier series, determination of Fourier coefficients, Dirichlet's conditions of convergence and statement of the theorem on convergence of Fourier sine and cosine series.	Shubhankar Podder

		Laplace Transform and its application to ordinary differential equation, Laplace transform and inverse Laplace transform, statement of existence theorem.	Arkopriya Mallick