DEPARTMENT OF MATHEMATICS
SONAMUKHI COLLEGE
SONAMUKHI, BANKURA, WEST BENGAL

For candidates admitted from 2017 - 2018 onwards (Under CBCS)

PROGRAMME TITLE: B. SC. MATHEMATICS (HONS.) (CBCS)

Programme Outcomes (PO)

Upon successful completion of the programme, the students should develop the following abilities among themselves.

PO Number	Description
PO - 01	To acquire a strong knowledge of fundamental principles and concepts of mathematics and mathematical computing with their applications to Industries, Engineering Sciences, Biology, and Environmental Sciences.
PO - 02	To gain a commendable foundation on various branches of mathematics and its interconnections with other disciplines to face real-life problems to become self-empowered in society and to lead others in society.
PO - 03	To develop problems solving skills, cultivating strong logical thinking, aptitude skills computational skills, computer skill, programming, self-confidence for better employability.
PO - 04	To develop the skill of thinking critically on abstract ideas of Mathematics.
PO - 05	To apply critical thinking skills to solve complex real-world problems.
PO - 06	To acquire knowledge to pursue the related Post-Graduate course of studies and researches in related areas both academic and others.
PO - 07	To conceive and plan a high-quality research project in the appropriate disciplinary or multidisciplinary context.
PO - 08	To exhibit disciplined work habits as an individual.
PO - 09	To crack various competitive examinations like JAM, Bank exams, SSC TET, CSC, RRB, etc.

Programme Specific Outcomes (PSO)

After the successful completion of B.Sc. Mathematics (Hons.) Programme the students will be able to:

PSO Number	Description
PSO - 01	Understand the mathematical concepts and application in the field of Algebra, Analysis, Statistics, Operations Research, Number Theory, Dynamics, Graph theory, Numerical Analysis, etc.
PSO - 02	Learn and apply the skill of computer programming in C.
PSO - 03	Acquire conceptual knowledge of mathematical science for analyzing and addressing real-world problems.
PSO - 04	Develop mathematical models related to some real-world problems and solve them.
PSO - 05	Acquire sufficient knowledge and proficiency in the use of appropriate technology to assist in the learning and investigation of mathematics.
PSO - 06	Equip themselves sufficiently in both analytical and computational skills in Mathematics which will help them to face different competitive examinations for various jobs in different fields, and to establish a carrier in mathematics through higher studies and researches.
PSO - 07	Grow themselves as hard-worker, strongly committed, and devoted to any particular aim which is necessary to be successful in life.

Course Outcomes (CO)

Semester	Course Code	Course Title	CO No	Course Outcomes
I	SH/MTH/101/C-1	Calculus, Geometry & Differential Equation	CO-1	Gain clearer concepts of Higher Order Derivative and, understand Leibniz rule and its applications. Understand the curvature, radius of curvature in Cartesian and Polar coordinates.
			CO-2	Learn about applications of definite integral to compute arc length, area, volume, etc.
			CO-3	Learn classification of conics using discriminant and acquire knowledge about different conics, polar equation of conics
			CO-4	Gain the ability to relate the properties of spheres, cones, conicoids (hyperboloid, paraboloid, or ellipsoid), and generating line with their subjects during the course of study.
			CO-5	Understand linear and non-linear differential equations and methods of solutions of a variety of first-order differential equations with an emphasis on linear equations.
			CO-6	Learn to model different real-life problems and solve them.

I	SH/MTH/ 102/C-2	Algebra	CO-7	To become familiar with the concept of complex numbers including its representation and De Moivre's theorem.	
			CO-8	Analyze and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization.	
			CO-9	know the application of relations between the roots and coefficients of an equation.	
			CO-10	Learn the solution technique of a cubic and bi-quadratic equation.	
			CO-11	Gain knowledge on Matrices, operation on matrices, echelon form and row reduced form, inverse of a matrix, rank of a matrix. Gain proficiency in solving systems of linear equations using matrices.	
			CO-12	Acquire the idea of eigenvalues and eigen function and apply Cayley-Hamilton theorem to find the inverse of a matrix	
II	SH/MTH/ 201/C-3	Real Analysis	CO-13	To be familiar with the ordering, countability, Archimedian, Completeness properties of R.	
			CO-14	To be familiar with the concept of open set, closed set, limit point, isolated point, compact set.	
			CO-15	Relate the concepts of convergent, divergent and oscillating sequences.	
			CO-16	Acquire the idea of limit supremum, limit infimum of sequences.	
			CO-17	Learn how to test the convergence of sequence and series.	
			CO-18	Learn how to evaluate the limit of the sequence and series.	
II	SH/MTH/ 201/C-4	Differential Equations and Vector Calculus	CO-19	Grasp the methods for solving second order linear differential equations with constant and variable coefficients	
			CO-20	Learn to solve a system of ODE	
			CO-21	Be able to solve real-life problems by constructing ordinary differential equations	
			CO-22	Assimilate the concepts of Equilibrium points, Interpretation of the phase plane .	
			CO-23	Acquire knowledge about vector triple product, and operations with vector-valued function.	
			CO-24	Gain the concept of divergence, curl and integration of vector point functions.	
III	SH/MTH/ 301/C-5	Theory of Real functions & Introduction to Metric Space	CO-25	Learn about continuous and differentiable functions from pure analytical point of view.	
			CO-26	Aware of the characteristic of continuous functions, e.g. boundedness property, intermediate-value property, interval preservation property, etc.	
			CO-27	Learn the uniform and non-uniform continuity of a real valued function, its various properties and its difference from the continuous functions.	
			CO-28	Gain knowledge of Rolle's theorem, Mean Value Theorem and Fundamental theorems and develop the knowledge to apply these theorems to evaluate the derivatives of a function at a point .	
			CO-29	Explore the basic concept of metric space, sub-space.	
			CO-30	Grasp the idea of Open balls, Closed balls, Open Sets, Closed Sets and Limit points in a metric space.	
III	SH/MTH/ 302/C-6	Group Theory-I	CO-31	Be able to determine and verify whether a given abstract structure forms a group or not.	
			CO-32	Learn the various properties of different groups including	

				Dihedral group, Quaternion group and Permutation group.
			CO-33	Know the concepts of subgroups, cyclic subgroups, normal subgroups, quotient group.
			CO-34	Explore the notion of Coset, Lagrange theorem and its consequences.
			CO-35	Be introduced with the idea of external direct product of finite number of groups and Cauchy's theorem for finite Abelian group.
			CO-36	Gain the knowledge about group homomorphism and their properties.
III	SH/MTH/ 303/C-7	Numerical Methods	CO-37	Recognize difference operators and apply the concept of interpolation.
			CO-38	Learn to solve algebraic and transcendental equations using various methods.
			CO-39	Identify the various methods of solving simultaneous linear algebraic equations.
			CO-40	Learn the technique of evaluating a definite integral numerically.
			CO-41	Can solve problems on higher order differential equations using Euler's, Runge- kutta methods.
			CO-42	Learn the use of mathematical softwares or computer programming language (C) to evaluate any particular numerical problem like solution of an equation, evaluation of integrations, etc.
III	SH/MTH /305/SEC-1	Programming using C	CO-43	Understand basic structure of the C-programming, and usage of constants and variables.
			CO-44	Know about Data types, Operators and Expressions in C.
			CO-45	Understand the decision making statements and looping structures in C.
			CO-46	Understand the concept of arrays in a C program.
			CO-47	Learn to incorporate user-defined functions in a C program.
			CO-48	To become expert in writing C program to solve numerical problems.
IV	SH/MTH/ 401/C-8	Riemann Integration and Series of Functions	CO-49	Can analyze the concept of Darboux integrability, Riemann integrability and fundamental theorems of calculus.
			CO-50	Acquire the knowledge of Riemann integrability for piecewise continuous functions and monotone functions and algebra of integrable functions.
			CO-51	Know the Concept of improper integrals and its convergence and different properties.
			CO-52	Learn Pointwise and uniform convergence of a sequence and series of real valued functions.
			CO-53	Develop the Fourier series, Riemann Lebesgue Lemma, Bessel's inequality, Perseval's identity, Dirichlet's conditions for expansion of a real valued function in to a Fourier.
			CO-54	Know the Power series and its convergence, Cauchy-Hadamard theorem and radius of convergence.
IV	SH/MTH/ 402/C-9	Multivariate Calculus	CO-55	Understand the fundamental concepts of functions with several variables & the notions of limit, continuity and derivability for a function of double variable.
			CO-56	Know the sufficient condition of Differentiability, chain rule and directional derivative.

			CO-57	Learn to find the extreme value for a function in two variables in both constrained And unconstrained cases.
			CO-58	Grasp the concept of multiple integrals and its evaluations. Also, learn about change of variables in double and triple integrals.
			CO-59	Understand and work with the problems related to ordinary integrals of vectors, line integrals surface and volume integrals
			CO-60	Gain the knowledge on the concept of divergence, curl and integration of vector point functions.
IV	SH/MTH/ 403/C-10	Ring Theory and Linear Algebra-I	CO-61	Explore the basic concepts of ring and know the various properties of several examples of rings.
			CO-62	Identify the properties which make a ring an integral domain or a field. Also, understand the idea of a factor ring.
			CO-63	Find a basis of a vector space by extension, deletion and replacement theorems.
			CO-64	Able to visualize the concepts of ring homomorphism and isomorphism.
			CO-65	Understand the basic concepts of vector space and subspaces, linear dependence, linear independence, dimension of a subspace.
			CO-66	Determine the rank and nullity of the space and matrix of Linear transformation.
IV	SH/MTH /405/SEC-2	Graph Theory	CO-67	Understand graph theory in coherent and technically accurate manner.
			CO-68	Know to express a graph by Adjacency matrix and Incidence matrix and study the graph homomorphism.
			CO-69	Understand the concepts of Connectedness in graph.
			CO-70	Know about Eulerian and Hamiltonian Graphs and Examples of the same.
			CO-71	Obtain the knowledge about trees, minimal spanning trees.
			CO-72	Learn the Dijkstra's algorithm and Warshall algorithm to find the shortest path between any two vertices in a graph.
V	SH/MTH/ 501/C-11	Partial Differential Equations and Applications	CO-73	Able to recognize and classify various PDEs of first order.
			CO-74	Learn about various methods of solving PDEs and use it to solve problems in physics like the motion of a vibrating string.
			CO-75	Can derive the Heat equation, Wave equation and Laplace equation.
			CO-76	Able to classify a second order linear PDE as hyperbolic, parabolic or elliptic. Also, can reduce it to its canonical forms.
			CO-77	Apply problem-solving using concepts and techniques from PDE's and Fourier analysis applied to diverse situations in physics, engineering, and in other mathematical contexts.
			CO-78	Know the principles of projectiles, central force, moment of inertia and gain ability to analyze the practical problems
V	SH/MTH/ 502/C-12	Group Theory - II	CO-79	Learn the notion of automorphism, be able to identify characteristic subgroup and commutator subgroup.
			CO-80	Explore the properties of external direct product and internal direct product and can apply it to solve related problems.
			CO-81	Learn the fundamental theorem for finite abelian groups and can determine the number of non-isomorphic abelian groups of a given order.
			CO-82	Know the basic idea of Group actions, stabilizers and kernels.

				Also, be able to find the permutation representation associated with a given group action.
			CO-83	Understand the class equation of a group and can apply it to study few properties of the group.
			CO-84	Learn the Syllow's theorems related to Group theory and can apply them to test whether a given group is simple or not.
V	SH/MTH /503/DSE-1	Linear Programming	CO-85	Formulate and solve L.P.P by using Simplex, Big M and Two Phase simplex methods.
			CO-86	Can formulate the dual of a given LPP and find the solution of a LPP by solving its dual.
			CO-87	Acquire the knowledge on solving transportation problems.
			CO-88	Explore the technique of solving an Assignment problem.
			CO-89	Recall the basic concepts and acquire the knowledge on Games & Strategies.
			CO-90	Learn the various solution techniques of a game problem.
V	SH/MTH /504/DSE-2	Probability and Statistics	CO-91	Understand the basic concepts of probability, conditional probability and independent events and related Baye's theorem.
			CO-92	Recall the concept of random variables (in one and two dimension) and learn about various types of distribution functions.
			CO-93	Evaluate mathematical expectation and derive moment generating function and characteristic functions of the data.
			CO-94	Learn and apply Chebyshev's inequality, Central limit theorem and the basics about Markov Chain.
			CO-95	Understand the basic concept of random sampling.
			CO-96	Test the hypothesis for small samples using the concept of student's t-distribution and f distribution.
VI	SH/MTH/ 601/C-13	Metric Spaces and Complex Analysis	CO-97	Know the concepts of metric spaces and continuous function and gain knowledge to analyze the properties of continuous functions on different types of metric spaces.
			CO-98	Understand the concepts of connectedness and completeness in a metric space and gain knowledge to give examples.
			CO-99	Understand the notions of compactness and uniform continuity
			CO-100	Acquire the central ideas of Cauchy – Riemann equations and decide the analyticity of a complex function.
			CO-101	Develop an insight on contour integration and present the emphasis of Cauchy- Goursat theorem in simply and multiply connected domains.
			CO-102	Can evaluate a contour integral using Cauchy's integral formula and be accomplished in implementing the Liouville's theorem, and the maximum modulus principle.
VI	SH/MTH/ 602/C-14	Ring Theory and Linear Algebra II	CO-103	Understand the properties of polynomial rings.
			CO-104	Generalize the concept of divisibility, primality and irreducibility of integers in a ring setup and understand the concept of ED, PID, UFD.
			CO-105	Learn to work with dual spaces and double dual spaces, and realize the identification of transformations in the double dual space with the vectors.
			CO-	Can obtain the Jordan form and other canonical forms of a linear

			106	transformation.
			CO-107	Gain knowledge about the concept of inner product spaces and can construct an orthonormal basis of a vector space by Gram-Schmidt process
			CO-108	Visualize and work with Orthogonal projections and analyze a linear transformation by Spectral theory
VI	SH/MTH /603/DSE-3	Number Theory	CO-109	Understand the results involving divisibility and greatest common divisors and solve systems of linear congruence.
			CO-110	Understand the concepts of the linear Diophantine equation $ax + by = c$.
			CO-111	Apply Euler-Fermat's theorem to prove relations involving prime numbers.
			CO-112	Learn about various number-theoritic functions.
			CO-113	Understand the concept of Fermat's theorem, generalisation of Fermat's, Wilson's and Lagrange's theorem and gain the ability to solve the problems related to them.
			CO-114	Apply the law of quadratic reciprocity and other methods to classify numbers as primitive roots, quadratic residues, and quadratic non-residues.
VI	SH/MTH /604/DSE-4	Project Work	CO-115	Demonstrate a sound technical knowledge of their selected project topic.
			CO-116	Can take up any physical problem, model it mathematically and search for its possible solution.
			CO-117	Can develop themselves as future researchers in the field of Mathematics or any inter-disciplinary subject.
			CO-118	Communicate with the mathematicians and the community at large in written an oral forms.
			CO-119	Can enrich their presentation skills.
			CO-120	Can enrich the skill of using any word processing software like M S Word, MS Power Point, Latex, etc.

PROGRAMME TITLE: B. SC. MATHEMATICS (PROG.) (CBCS)

Course Outcomes (CO)

Se me ste r	Course Code	Course Title	CO No	Course Outcomes
I	SP/MTH/ 101/C-1A	Calculus, Geometry & Differential Equation	CO-1	Gain clearer concepts of Higher Order Derivative and, understand Leibniz rule and its applications. Understand the curvature, radius of curvature in Cartesian and Polar coordinates.
			CO-2	Learn about applications of definite integral to compute arc length, area, volume, etc.
			CO-3	Learn classification of conics using discriminant and acquire knowledge about different conics, polar equation of conics
			CO-4	Gain the ability to relate the properties of spheres, cones, conicoids (hyperboloid, paraboloid, or ellipsoid), and generating line with their subjects during the course of study.
			CO-5	Understand linear and non-linear differential equations and methods of solutions of a variety of first-order differential equations with an emphasis on linear equations.
			CO-6	Learn to model different real-life problems and solve them.
II	SP/MTH/ 201/C-1B	Real Analysis	CO-7	To be familiar with the ordering, countability, Archimedian, Completeness properties of R.
			CO-8	To be familiar with the concept of open set, closed set, limit point, isolated point, compact set.
			CO-9	Relate the concepts of convergent, divergent and oscillating sequences.
			CO-10	Acquire the idea of limit supremum, limit infimum of sequences.
			CO-11	Learn how to test the convergence of sequence and series.
			CO-12	Learn how to evaluate the limit of the sequence and series.
III	SP/MTH/ 301/C-1C	Algebra	CO-13	To become familiar with the concept of complex numbers including its representation and De Moivre's theorem.
			CO-14	Analyze and interpret the concepts of divisibility, congruence, greatest common divisor, prime, and prime-factorization.
			CO-15	know the application of relations between the roots and coefficients of an equation.
			CO-16	Learn the solution technique of a cubic and bi-quadratic equation.
			CO-17	Gain knowledge on Matrices, operation on matrices, echelon form and row reduced form, inverse of a matrix, rank of a matrix. Gain proficiency in solving systems of linear equations using matrices.
			CO-18	Acquire the idea of eigenvalues and eigen function and apply Cayley-Hamilton theorem to find the inverse of a matrix
III	SP/MTH/ 304/SEC-1	Logic and Sets	CO-19	Relate symbolic laws of logic to natural languages, and determine the truth value of unquantified sentences using logical rules.
			CO-20	Determine if a quantified statement involving either one or two quantifiers is true or false

			CO-21	Determine the converse, inverse and contrapositive of a given implication and explain their relationships.
			CO-22	Understand the basic principles of sets and operations in sets
			CO-23	Construct proofs of basic set-theoretic identities involving unions, intersections, and cartesian products
			CO-24	Demonstrate an understanding of relations and functions and be able to determine their properties.
IV	SP/MTH/ 401/C-1D	Differential Equations and Vector Calculus	CO-25	Grasp the methods for solving second order linear differential equations with constant and variable coefficients
			CO-26	Learn to solve a system of ODE
			CO-27	Be able to solve real-life problems by constructing ordinary differential equations
			CO-28	Assimilate the concepts of Equilibrium points, Interpretation of the phase plane .
			CO-29	Acquire knowledge about vector triple product, and operations with vector-valued function.
			CO-30	Gain the concept of divergence, curl and integration of vector point functions.
IV	SP/MTH/ 404/SEC-2	Graph Theory	CO-31	Understand graph theory in coherent and technically accurate manner.
			CO-32	Know to express a graph by Adjacency matrix and Incidence matrix and study the graph homomorphism.
			CO-33	Understand the concepts of Connectedness in graph.
			CO-34	Know about Eulerian and Hamiltonian Graphs and Examples of the same.
			CO-35	Obtain the knowledge about trees, minimal spanning trees.
			CO-36	Learn the Dijkstra's algorithm and Warshall algorithm to find the shortest path between any two vertices in a graph.
V	SP/MTH/ 501/DSE-1A	Linear Programming	CO-37	Formulate and solve L.P.P by using Simplex, Big M and Two Phase simplex methods.
			CO-38	Can formulate the dual of a given LPP and find the solution of a LPP by solving its dual.
			CO-39	Acquire the knowledge on solving transportation problems.
			CO-40	Explore the technique of solving an Assignment problem.
			CO-41	Recall the basic concepts and acquire the knowledge on Games & Strategies.
			CO-42	Learn the various solution techniques of a game problem.
V	SP/MTH/ 504/SEC-3	Programming Language: C	CO-43	Understand basic structure of the C-programming, and usage of constants and variables.
			CO-44	Know about Data types, Operators and Expressions in C.
			CO-45	Understand the decision making statements and looping structures in C.
			CO-46	Understand the concept of arrays in a C program.
			CO-47	Learn to incorporate user-defined functions in a C program.
			CO-48	To become expert in writing C program to solve numerical problems.
VI	SP/MTH/ 601/DSE-1B	Probability and Statistics	CO-49	Understand the basic concepts of probability, conditional probability and independent events and related Baye's theorem.
			CO-50	Recall the concept of random variables (in one and two

				dimension) and learn about various types of distribution functions.
			CO-51	Evaluate mathematical expectation and derive moment generating function and characteristic functions of the data.
			CO-52	Learn and apply Chebyshev's inequality, Central limit theorem and the basics about Markov Chain.
			CO-53	Understand the basic concept of random sampling.
			CO-54	Test the hypothesis for small samples using the concept of student's t-distribution and f distribution.
VI	SP/MTH/ 604/SEC-4	Numerical Analysis with practical	CO-55	Recognize difference operators and apply the concept of interpolation.
			CO-56	Learn to solve algebraic and transcendental equations using various methods.
			CO-57	Identify the various methods of solving simultaneous linear algebraic equations.
			CO-58	Learn the technique of evaluating a definite integral numerically.
			CO-59	Can solve problems on higher order differential equations using Euler's, Runge- kutta methods.
			CO-60	Learn the use of mathematical softwares or computer programming language (C) to evaluate any particular numerical problem like solution of an equation, evaluation of integrations, etc.