SARAT CENTENARY COLLEGE

Dhaniakhali, District-Hooghly, West Bengal

DEPARTMENT OF MATHEMATICS

PROGRAMME OFFERED 3-YEAR DEGREE /

4- YEAR HONOURS IN MATHEMATICS

Under Curriculum and Credit Framework for Undergraduate Programmes (CCFUP) as per NEP, 2020

Model Reference: Syllabus for Mathematics (CCFUP), University of Burdwan,

Effective from 2023-2024

PROGRAMME OUTCOME (PO)

PO1: Students will acquire basic Practical skills & Technical knowledge along with domain knowledge of different subjects in the science stream.

PO2: Scientific temper will be developed in Students.

PO3: Students will become employable; they will be eligible for career opportunities in Industry, or will be able to opt for entrepreneurship.

PO4: Students will possess basic subject knowledge required for higher studies, professional and applied courses like Management Studies, Law etc.

PO5: Students will be aware of and able to develop solution-oriented approach towards various Social and Environmental issues.

PROGRAMME SPECIFIC OUTCOME(PSO)

PSO1: A student should be able to recall basic facts about mathematics and should be able to display knowledge of conventions such as notations, terminology.

PSO2: A student should get adequate exposure to global and local concerns that explore them many aspects of mathematical sciences.

PSO3: Student is equipped with mathematical modeling ability, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

PSO4: Student should be able to apply their skills and knowledge that is translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

PSO5: Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

PSO6: The program fosters an appreciation of the

interconnections among different branches of Mathematics.

PSO7: Students gain sufficient knowledge to pursue higher studies in Mathematics and other branches of science.

COURSE OUTCOME (CO):

SEMESTER-I

Course Code: MATH1011 (MAJOR COURSE)

Course Name: Calculus, Geometry &Vector Calculus

On completion of this portion of the course, a student will be able to:

CO1: Understand the nature of Hyperbolic functions.
CO2: Find higher order derivatives and apply the Leibnitz rule to solve problems related to such derivatives.

CO3:HelptounderstandbasicofCalculusandit'sapplicationsuchasknowledgeaboutconcavity,convexity, points of inflection, asymptotes, envelopes, rectilinear asymptotes (Cartesian & parametric form only) of a curve and tracing a curve

CO4: Derivation of reduction formula in Integral Calculus and gain knowledge to find arc length, area of surface evolution, parametric curves etc.

CO5: Help to learn the concept of Analytical Geometry as like : Reflection properties of conics, translation and rotation of axes, classification of conics, polar equations of conics, Spheres, Cylindrical surfaces. Central conicoids , paraboloids, plane sections of conicoids, Generating lines, classification of quadrics.

CO6: Gain knowledge vector valued functions and vector calculus.

CO7: Find gradient of scalar functions, divergence and curl of vector valued functions.
CO7: Use of software to plot curves and graphically obtain the surface of revolution of curves.
CO8: Visualize and graphically demonstrate geometric figures and classify different geometric solids using teaching aid - preferably free softwares.

Course Code: MATH1021 (MINOR COURSE)
Course Name: Calculus, Geometry &Vector Calculus

On completion of this portion of the course, a student will be able to:

CO1: Understand the nature of Hyperbolic functions.
CO2: Find higher order derivatives and apply the Leibnitz rule to solve problems related to such derivatives.

CO3: Help to understand basic of Calculus and it's application such as knowledge about concavity, convexity, points of inflection, asymptotes, envelopes, rectilinear asymptotes (Cartesian & parametric form only) of a curve and tracing a curve

CO4: Derivation of reduction formula in Integral Calculus and gain knowledge to find arc length, area of surface evolution, parametric curves etc.

CO5: Help to learn the concept of Analytical Geometry as like: Reflection properties of conics, translation and rotation of axes, classification of conics, polar equations of conics, Spheres, Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, Generating lines, classification of quadrics.

CO6: Gain knowledge vector valued functions and vector calculus.

CO7: Find gradient of scalar functions, divergence and curl of vector valued functions.
CO7: Use of software to plot curves and graphically obtain the surface of revolution of curves.
CO8: Visualize and graphically demonstrate geometric figures and classify different geometric solids using teaching aid - preferably free softwares.

Course Code: MATH1051 (SKILL ENHANCEMENT COURSE)
Course Name: Graph Theory

On completion of this portion of the course, a student will be able to:

CO1: Define graphs, complete graphs, bipartite graphs, isomorphism of graphs
CO2: Interpret the concept of Eulerian and Hamiltonian graphs.
CO3: Apply matrix representation to analyze graphs.
CO4: Create examples of trees and spanning trees.
CO5: Analyze and compare planar and non-planar graphs.
CO6: Evaluate the effectiveness of different graph coloring strategies.

SEMESTER-II

Course Code: MATH2011 (MAJOR COURSE)
Course Name: Introductory Algebra and Number Theory

On completion of this portion of the course, a student will have a clear-cut understanding of some important concepts of Classical Algebra, Abstract Algebra & Number theory as follows:

CO1: Prove how certain number theoretical theorems can be applied to solve simple Diophantine equations.

CO2: Explain theory of congruence with examples.

CO3: Explain Euler's phi functions and its properties.

CO4: Know about primitive roots of primes and continued fractions.

CO5:Know about relation between roots and coefficients, transformation of the equation, Descartes rule of signs.

CO6: Find the solution of cubic equation by Cardan's method and the solution of biquadratic equation by Ferrari's method.

CO7: Know about the Cauchy-Schwartz inequality and the inequality involving AM≥GM≥HM.

CO8:Help to understand Groups, permutation groups, Matrix groups with various examples.

CO9: Know about subgroups, coset, normal subgroup, cyclic group with examples.

CO10: Prove Lagrange's theorem and by apply this theorem to solve various problems of group theory.

CO11: Know about ring, ideals ,integral domain ,field with examples and its properties.

Course Code: MATH2021 (MINOR COURSE)
Course Name: Introductory Algebra and Number Theory

On completion of this portion of the course, a student will have a clearcut understanding of

some important concepts of Classical Algebra, Abstract Algebra & Number theory as follows:

CO1: Prove how certain number theoretical theorems can be applied to solve simple Diophantine equations.

CO2: Explain theory of congruence with examples.

CO3: Explain Euler's phi functions and its properties.

CO4: Know about primitive roots of primes and continued fractions.

CO5:Know about relation between roots and coefficients, transformation of the equation, Descartes rule of signs.

CO6: Find the solution of cubic equation by Cardan's method and the solution of biquadratic equation by Ferrari's method.

CO7: Know about the Cauchy-Schwartz inequality and the inequality involving AM≥GM≥HM.

CO8:Help to understand Groups, permutation groups, Matrix groups with various examples.

CO9: Know about subgroups, coset, normal subgroup, cyclic group with examples.

CO10: Prove Lagrange's theorem and by apply this theorem to solve various problems of group theory.

CO11: Know about ring, ideals, integral domain, field with examples and its properties.

Course Code: MATH2051 (SKILL ENHANCEMENT COURSE)
Course Name: Programming in C

On completion of this portion of the course, a student will be able to:

CO1: Uses of different types of operators with precedence, formatted and non-formatted input output statements, branching and looping statements for decision making.
CO2: Help to understand the concept of array variables.
CO3: How to use User-defined function along with string handling function.
CO4: Know about the writing of different C programming using structures and pointers.
CO5: Understand the importance of C programming which are very good programming tools for solving many real life problems.

SEMESTER-III

Course Code: MATH3011 (MAJOR COURSE)
Course Name: Real Analysis I

On completion of this portion of the course, a student will be able to:

CO1: Concept of countable sets, uncountable sets, bounded and unbounded sets in $\mathbb{R}$, supremum and infimum of a set and their properties
CO2: Know about Archimedean property of $\mathbb{R}$ and its applications.
CO3: Understand the concept of interior point, open set, limit point of a set, isolated point, derived set, closed set.
CO4: Explain the theory of Bolzano-Weierstrass for set and Heine-Borel theorem.
CO5: Learn about real sequence, bounded sequence which are convergent and non-convergent.
CO6: Find the relation between the limit of a set and the limit of a convergent sequence of distinct elements.
CO7: Know about the sequences which are Cauchy sequence and its convergent criteria.
CO8:Determine which infinite series of real numbers is convergent and which is not convergent by using various test such as comparison tests, De Morgan tests, D'Alembert's ratio test, p-series, Cauchy's root test, Raabe's test, Gauss test, Logarithmic test, integral test.
CO9: Calculate which alternating series of real numbers is convergent by using Leibnitz test.
CO10: Know about Absolute and conditional convergence.
CO11: Learn about limit of functions, sequential criterion for limits, Algebra of limits for functions, effect of limit on inequality involving functions, infinite limit and limit at infinity. Some important examples of limits.
CO12: Gain knowledge about continuity and uniform continuity of real valued functions defined on subsets of $\mathbb{R}$ including their inter relationship.
CO13: Explain Bolzano's theorem of continuity, intermediate value theorem, fixed point theorem and apply these theorem to solve various problems of real numbers.

Course Code: MATH3012 (MAJOR COURSE)
Course Name: Linear Algebra

On completion of this portion of the course, a student will be able to:

CO1: Know about Vector spaces and its properties.
CO2: How to find a basis and dimension of a vector space.
CO3: Find rank and nullity of a linear transformation and also matrix representation of a linear transformation.
CO4: Calculate the transpose of a linear transformation and its matrix representation
CO5: Know about invertibility and isomorphisms of a linear transformation.
CO6: Find rank of a matrix by using elementary operations.
CO7: Evaluate eigen values and eigen vectors of a matrix and also find the inverse of a matrix by using Cayley-Hamilton theorem.
CO8: Solve the systems of linear equations by using Gaussian elimination method and matrix inversion method.
CO9: Find the characteristic polynomial and the minimal polynomial of a linear operator and canonical forms of a matrix.

CO10: Know about Inner product spaces, norms and its properties.
CO11: Obtain an orthonormal basis of an inner product spaces by applying Gram-Schmidt orthogonalization process.
CO12: How to reduce a quadratic form to normal form by orthogonal transformation.

Course Code: MATH3051 (SKILL ENHANCEMENT COURSE)
Course Name: Mathematical Modelling

On completion of this portion of the course, a student will be able to:

CO1: Gain knowledge about modelling and formation of various models and their real life application.
CO2: Estimate relationship between variables by using of linear regression for modelling.
CO3: Know about Exponential models which help to comprehend the rapid and often accelerating changes that occur in diverse natural and social systems.
CO4: Know about Logistic models and their applications in population studies, ecology and epidemiology
CO5: Define optimization models and their applications and use of linear programming and optimization techniques to minimize or maximize objectives.
CO6: Gain knowledge about importance of optimization model in resource allocation, production planning, decision making.
CO7: Know about time series models and their application and importance of time series models in analyzing trends, seasonality and forecasting future outcomes with applications.
CO8: Analyze and solve the real world problems mathematically.

SEMESTER-IV

Course Code: MATH4011 (MAJOR COURSE)
Course Name: Metric Spaces

On completion of this portion of the course, a student will be able to understand and appreciate the concept of a metric space as follows:
CO1: understand and appreciate the concept of a metric space , open set, closed sets and be able to recognize standard examples
CO2: Analyze the properties of open and closed balls, neighbourhoods, interior and exterior points, and boundaries of sets in metric spaces.
CO3: Explore concepts such as limit points, closure, boundedness, and equivalent metrics
CO4: Demonstrate knowledge of convergence, Cauchy sequences and bounded sequences.
CO5: Understand the role of completeness in metric spaces and explore dense and nowhere dense sets.
CO6: Apply key theorems like Baire's category theorem, Cantor's intersection theorem and the completion of metric spaces.
CO7: Analyze the completeness and incompleteness properties of spaces like $\mathbb{R}^n$, C[a,b], l_p, l_∞.
CO8: Evaluate limits, continuity and uniform continuity of mapping in metric spaces.

CO9: Utilize concepts like homeomorphisms and Banach's contraction principle for solving problems including ODEs and implicit function.
CO10: Analyze the properties of connectedness, separated sets and connected subsets in $\mathbb{R}$. And establish the role of continuity in maintaining connectedness.
CO11: Understand and apply properties like open cover, sequential compactness and B-W compactness and explore the relationships between compactness, completeness and boundedness and use tools like lebesgue covering lemma.
CO12: Assess the first and second countability of a metric space and explore separability and Lindelöf properties in various metric spaces.

Course Code: MATH4012 (MAJOR COURSE)
Course Name: Group Theory & Ring Theory

On completion of this course, students will gain a strong theoretical and practical foundation in group theory and ring theory as follows:

CO1: Define and explore homomorphisms, isomorphisms, automorphisms and releted concepts like inner automorphism and endomorphism.
CO2: Analyze quotient groups, commutator subgroups, characteristic subgroups and simple groups and study specific groups like the dihedral and quaternion groups.
CO3: Understand and apply isomorphism theorems (1^{st}, 2^{nd},3^{rd}) and the correspondence theorem.
CO4: Study concepts like normalizers, maximal normal subgroups and their role in group classification.
CO5: Explore the action of a group on a set, representation via homomorphisms, and Cayley's theorem.
CO6: Analyze stabilizers, orbits, class equations, and conjugacy classes. Apply theorems like Burnside's theorem and study p-groups, Cauchy's theorem, and Sylow theorems.
CO7: Differentiate between direct product and direct sum of groups and analyze their properties and also Study the semi-direct product and the representation of finite abelian groups.
CO8: Define ring homomorphisms and study quotient rings along with the isomorphism theorems (1st, 2nd, and 3rd). Understand and explore maximal, prime, and primary ideals, including their existence and properties.
CO9: Investigate irreducible and prime elements and their roles in ring theory.
Explore advanced ring structures like Euclidean domains, Principal Ideal Domains (PIDs), and Unique Factorization Domains (UFDs).
CO10: Analyze polynomial rings F[x] over a field F, integral domains, and irreducibility criteria for polynomials.

Course Code: MATH4013 (MAJOR COURSE)
Course Name: Multivariate Calculus & Tensor Calculus

On completion this course, students will master concepts in multivariable calculus and tensor calculus as follows:
CO1: Analyze the continuity and limits of functions of n-variables, including repeated and double limits.

CO2: Understand and apply partial derivatives, Euler's theorem, and total differentiability. Utilize chain rules, directional derivatives, Jacobians, and gradients in problem-solving.
CO3: Determine tangent planes and solve extrema problems using the method of Lagrange multipliers for constrained optimization.
CO4: Comprehend the concept and computation of double and triple integrals.Apply changes in the order of integration and transformations in different coordinate systems (cylindrical and spherical).
CO5: Use multiple integrals for determining volumes, surface areas, and solving real-world problems.
CO6: Understand and apply Leibniz's rule for differentiation under the integral sign.
CO7: Understand the historical development and concept of tensors as a generalization of vectors in E_2, E_3 and E_n.
CO8: Familiarize with Einstein's summation convention, Kronecker delta, and basic algebra of tensors.
Perform operations like addition, subtraction, scalar multiplication, outer and inner products, and contraction.
CO9: Apply the quotient law for tensor operations.
CO10: Explore Riemannian space, line elements, and metric tensors.
CO11: Compute and interpret the magnitude of vectors, angles between vectors, and transformations involving Christoffel symbols. Perform covariant differentiation and compute gradient, divergence, curl, and Laplacian of tensor fields.
CO12: Analyze Riemann-Christoffel curvature tensors, Ricci tensors, and scalar curvatures.
CO13: Develop an understanding of Einstein's space and its applications.

Course Code: MATH4021 (MINOR COURSE)
Course Name: Ordinary Differential Equations

By completing this course, students will develop a strong foundation in solving and analyzing differential equations of various types and orders. Also they will be able to..

CO1: Understand and analyze Picard's existence theorem (statement only) for initial value problems.
CO2: Solve exact differential equations and identify conditions for integrability.
CO3: Work with equations of first order and higher degrees, including those solvable for p $=\frac{dy}{dx}$, y or x.
CO4: Identify and solve singular solutions, including Clairaut's equations, and understand singular solutions as envelopes to families of general solutions.
CO5: Solve second-order linear differential equations and understand the concept of linearly independent solutions and the Wronskian. Derive general solutions for second-order equations with constant coefficients and compute particular integrals (P.I.) for various types of functions.
CO6: Apply the method of variation of parameters to find particular solutions.
CO7: Solve homogeneous linear equations of n-th order with constant coefficients and reduce the order of second-order equations when one solution is known.
CO8: Solve systems of simultaneous linear ordinary differential equations involving two dependent variables.

Work with differential equations of the form $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$.

CO9: Analyze and solve equations in Paffian form Pdx + Qdy + Rdz = 0 , with a focus on the necessary and sufficient conditions for the existence of integrals.

CO10: Conduct qualitative studies of differential equations, including equilibrium points and their classifications.

CO11: Perform phase plane analysis and plot phase diagrams for simple problems, enhancing understanding of system behavior.