SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S01NCMTH01**	Complex Analysis I	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply the concepts of complex numbers, limits, continuity, differentiability, and analytic functions to analyze complex functions.

CLO2: Apply Cauchy-Riemann equations and analyze properties of analytic and harmonic functions.

CLO3: Evaluate complex integrals using contours, Cauchy's theorem, Cauchy integral formula, and related results.

CLO4: Analyze complex functions using major theorems such as Liouville's theorem and maximum modulus principle.

CLO5: Analyze power series, including their convergence, continuity, differentiation, and integration.

CLO6: Apply the residue theorem to evaluate integrals and demonstrate basic understanding of Mobius transformations and their role in mapping complex functions.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Argument of complex number, Limit and continuity of a complex function, Derivative of a complex function, Cauchy-Riemann equations, Sufficient conditions for differentiability, Polar coordinates, Analytic functions, Harmonic functions, Exponential functions, Logarithmic function, Branches and derivative of logarithms.	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO1, CLO2
II	Derivative of function $w(t)$, Definite integrals of function $w(t)$, Contours, Contour integrals and examples, Upper bounds for moduli of contour integrals, Anti-derivative, Cauchy's theorem, Cauchy-Goursat's theorem (without proof), Simply and multiply connected domains, principle of deformation of paths, Cauchy integral formula, Gauss mean value theorem.	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO3
III	An extension of the Cauchy integral formula and its consequences, Morera's theorem, Cauchy inequality, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus principle, Taylor's theorem, Absolute and uniform convergence of power series, Continuity of sums of power series, Integration and differentiation of a power series.	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning, ICT-Enabled Learning	CLO4, CLO5

IV	Laurent's theorem, Classification of singularities, Residues, Cauchy's residue theorem, Residues at poles, Evaluation of improper real integrals, Jordan's lemma (without proof), Definite integrals involving Sines and Cosines, Mobius transformation and an implicit form.	Seminars, Problem-Based Learning, Collaborative Learning, ICT-Enabled Learning	CLO6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term test (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	15	2	4	7	13
II	CLO3	15	2	4	7	13
III	CLO4, CLO5	15	2	3	7	12
IV	CLO6	15	2	3	7	12
		60 (4Hrs/week)	**8**	**14**	**28**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	2	-	–	1	1	–	–	-
CLO2	3	3	2	–	–	1	1	–	–	–
CLO3	3	3	3	-	-	2	1	–	–	1
CLO4	2	3	2	–	-	2	1	–	–	–
CLO5	2	2	2	–	1	1	1	–	–	–
CLO6	3	3	3	1	1	2	1	–	–	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Publisher	Edition/Year
1	Complex Variables and Applications (Eighth edition)	Churchil, R.V., Brown, J. and Verle, R.	2009	McGraw-Hill
2	Complex Variables Theory and Applications (Second Edition)	Kasana H. K.	2005	Prentice-Hall
3	A Pathway to Complex Analysis	Kumaresan S.	2021	Techno World
4	Functions of One Complex Variable (Second Edition)	Conway J. B.	1978	Narosa
5	Foundations of Complex Analysis	Ponnusamy S.	1995	Narosa

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1.	NPTEL course on Complex Analysis video lectures.	https://nptel.ac.in/courses/111103070
2.	NPTEL course on Complex Analysis video lectures.	https://www.youtube.com/playlist?list=PLyqSpQzTE6M_fDgY78f5lAT5zR6xHAajo

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S01NCMTH02**	Functions of Several Real Variables	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply the concepts of Euclidean space R^n, inner product, convex sets, path-connected sets, and geometric structures to analyze functions of several variables.

CLO2: Analyze limit and continuity of functions $f : R^n \to R^m$, including the relationship among continuity, convexity, and intermediate value property; and apply results such as the Bivariate Intermediate Value Theorem and Implicit Function Theorem.

CLO3: Apply the concept of total (full) derivative to compute derivatives of functions $f : R^n \to R^m$, including the use of matrix representation, chain rule, and Increment Lemma.

CLO4: Evaluate partial and higher-order mixed partial derivatives, gradients, and apply results such as Rolle's Theorem and Mean Value Theorem in two variables context.

CLO5: Analyze differentiability and directional derivatives, examine the relationship between continuity, partial derivatives, Jacobian matrix and related conditions.

CLO6: Apply multivariable calculus techniques such as Taylor's theorem, Lagrange multiplier theorem, and critical point analysis to solve optimization problems and classify extrema.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	**Limits and Continuity** Euclidean space R^n and its basic properties; Inner product and Product order; n-interval, Ball, and Hyper cuboid; Line segment and Regular path; Convex set and Path-connected set; Bounded, Monotonic, and Convex function $f : R^n \to R$; Local extremum of a function $f : R^n \to R$; Limit and continuity of functions $f : R^n \to R^m$; Examples and results on limit and continuity; Relation between continuity and convexity; Bivariate Intermediate Value Theorem; Implicit Function Theorem (without proof);	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO1, CLO2
II	**Total Derivation** Linear maps $T : R^n \to R^m$; Matrix representation of a linear map $T : R^n \to R^m$; New definition of derivation of $f : R \to R$ at a; (Total or Full) derivation $Df(a)$ of $f : R^n \to R^m$ at a; Uniqueness of derivation and the Chain rule; Examples and results on total derivation; Increment Lemma and its applications;	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO3

III	**Partial and Directional Derivatives** Partial derivatives $D_i f(a)$ of $f : R^n \to R$ at a point a; The Gradient $\nabla f(x_0, y_0)$; Higher ordered partial derivatives; Mixed partial derivatives; Rectangular Rolle's Theorem; Rectangular Mean Value Theorem; Jacobian matrix $f'(a)$ of $f : R^n \to R^m$ at a point a; Sufficient condition for differentiability. Directional derivative, its examples and properties; Relation among continuity and three types of derivatives;	Seminars, Problem-Based Learning, Collaborative Learning, ICT-Enabled Learning	CLO4, CLO5
IV	**Applications** Bivariate Mean Value Theorem; Bivariate Taylor Theorem; Lagrange Multiplier Theorem; Boundary points and critical points; Local extrema and saddle points; Discriminant test (without proof); Classical version of Implicit Function Theorem (only statement);	Seminars, Problem-Based Learning, Collaborative Learning, Research-Oriented Learning	CLO6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term test (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	15	2	2	9	13
II	CLO3	15	1	3	9	13
III	CLO4, CLO5	15	1	2	9	12
IV	CLO6	15	1	2	9	12
		60 (4Hrs/week)	**5**	**9**	**36**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	2	2	–	1	–	–	–	2
CLO2	3	3	3	–	–	2	1	–	–	–
CLO3	3	2	3	2	3	1	–	–	–	2
CLO4	3	3	3	–	2	2	–	1	–	–
CLO5	3	3	3	–	3	2	–	–	1	–
CLO6	3	2	3	3	3	3	–	–	–	3

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	A Course in Multivariable Calculus and Analysis	S. R. Ghorpade and B. V. Limaye	2010	Springer
2	Principles of Mathematical Analysis	W. Rudin	3rd Edition 1983	Tata McGraw-Hill Publ. Co., New Delhi

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	MIT OpenCourseWare – Multivariable Calculus	https://ocw.mit.edu/courses/18-02sc-multivariable-calculus-fall-2010/
2	Paul's Online Math Notes – Multivariable Calculus	https://tutorial.math.lamar.edu/Classes/CalcIII/CalcIII.aspx

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S01NCMTH03**	Linear Algebra	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply the concepts of vector spaces, subspaces, bases, dimension, rank, and nullity to analyse linear structures including sequence and function spaces.

CLO2: Analyse linear transformations, their matrix representations, invertibility, and change of basis, and evaluate relationships such as similarity and dual spaces.

CLO3: Apply inner product space concepts, including orthogonality, Gram–Schmidt orthogonalization, and projections, to solve problems involving lengths, angles, and orthogonal decompositions.

CLO4: Evaluate eigenvalues and eigenvectors to diagonalize matrices and linear transformations, and apply these concepts to compute matrix exponentials.

CLO5: Analyse Jordan canonical forms, generalized eigenvectors, minimal polynomials, and the Cayley–Hamilton theorem to study the structure of linear operators.

CLO6: Apply the theory of quadratic forms, including diagonalization and classification, to analyse geometric structures such as level surfaces.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Vector Spaces: Quick review of vector spaces, examples of vector spaces including sequence spaces and function spaces, Subspaces, Bases, Dimensions, Row and column spaces, Rank and nullity, Bases for subspaces, Invertibility, Applications: The Wronskian.	Seminars, Problem-Based Learning, Inquiry-Based Learning, Collaborative Learning, ICT-Enabled Learning	CLO1
II	Linear Transformations: Basic properties of linear transformations, Invertible linear transformations, Matrices of linear transformations, Vector spaces of linear transformations, Change of bases, Similarity, Applications: Dual spaces, Adjoint (only definition and examples).	Seminars, Problem-Based Learning, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning	CLO2

III	Inner Product Spaces: Dot products and inner products, the lengths and angles of vectors, Matrix representations of inner products, Gram-Schmidt orthogonalization, Projections, Orthogonal projections (only definitions and examples). Diagonalization: Eigenvalues and eigenvectors, Diagonalization of matrices, Exponential matrices, Diagonalization of linear transformations.	Seminars, Problem-Based Learning, Inquiry-Based Learning, Research-Oriented Learning, ICT-Enabled Learning	CLO3, CLO4
IV	Jordan Canonical Forms: Basic properties of Jordan canonical forms, Generalized eigenvectors, the power A^k and the exponential e^A, Cayley-Hamilton theorem, the minimal polynomial of a matrix. Quadratic Forms: Basic properties of quadratic forms, Diagonalization of quadratic forms, A classification of level surfaces.	Seminars, Problem-Based Learning, Research-Oriented Learning, Micro-Projects, ICT-Enabled Learning	CLO5, CLO6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term tests (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1	15	2	4	7	13
II	CLO2	15	2	4	7	13
III	CLO3, CLO4	15	2	3	7	12
IV	CLO5, CLO6	15	2	3	7	12
		60 (4Hrs/week)	**8**	**14**	**28**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	3	2	2	2	1	1	1	2
CLO2	3	3	3	2	2	2	1	1	1	2
CLO3	3	3	3	2	2	2	1	1	1	2
CLO4	3	3	3	2	2	3	1	1	1	2
CLO5	3	3	2	2	2	3	1	1	2	2
CLO6	3	3	3	3	2	3	1	1	2	3

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Linear Algebra	Kwak J. H., Hong S.	2nd Ed. 2004	Birkhauser
2	Linear Algebra	Hoffman K., Kunze R.	2nd Ed. 2003	Prentice Hall of India
3	Topics in Algebra	Herstein I. N.	2nd Ed. 2006	Wiley Eastern Ltd., New Delhi
4	Linear Algebra	Sahai V., Bist V.	2002	Narosa Publishing House
5	Linear Algebra	Ramachandra Rao A., Bhimasankaram P.	2nd Ed. 2000	Hindustan Book Agency, TRIM-19
6	Linear Algebra Done Right	Axler S.	2nd Ed. 1997	Springer
7	Introduction to Linear Algebra	Strang G.	6th Ed. 2023	Wellesley Cambridge Press

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	"Linear Algebra: 1 Vector Spaces" – YouTube video playlist by S. Kumaresan	https://youtube.com/playlist?list=PLDzvuf9Uf4FPp5v4hCiPNdEXjV8IQJCmz&si=OWyY1vphLZR2Kvy0
2	"Linear Algebra: 2 Linear Maps" – YouTube video playlist by S. Kumaresan	https://youtube.com/playlist?list=PLDzvuf9Uf4FNk9q7NZQPyp6mstdl8-EW5&si=56_sHW0Q-FMS4ive
3	Linear Algebra – IIT Kanpur (NPTEL) by Prof. Arbind Kumar Lal	https://onlinecourses.nptel.ac.in/noc20_ma54/preview
4	Introduction to Linear Algebra by Gilbert Strang	https://math.mit.edu/~gs/linearalgebra/

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S01NEMTH01**	Ordinary Differential Equations	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Analyse linear independence of solutions using the Wronskian.

CLO2: Identify and solve Pfaffian differential equations using homogeneous and Natani's methods.

CLO3: Classify singularities of second-order linear differential equations.

CLO4: Construct series solutions near regular singular points.

CLO5: Explain the existence and uniqueness of solutions using Picard's theorem.

CLO6: Analyse critical points of autonomous systems.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Review of fundamentals of ordinary differential equations, The Wronskian and linear independence of solution, The method of undetermined coefficients, The method of Variation of Parameters. Pfaffian differential equation: homogeneous method and Natani's method.	Seminars, Problem-Based Learning, Inquiry-Based Learning, ICT-Enabled Learning, Collaborative Learning	CLO1, CLO2
II	Interval of convergence of Power series, real valued analytic function, second order linear homogeneous differential equation: classification of singularities, series solution near ordinary point, Legendre's differential equation, Legendre polynomial and its properties, Rodrigue's formula, Fourier-Legendre's expansion theorem, and its examples.	Seminars, Problem-Based Learning, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning	CLO3
III	Series solution near regular singular point: Frobenius Theorem (statement only), the point at infinity, Bessel's differential equation, Bessel's function of first kind and its properties, Fourier-Bessel's expansion theorem, and its examples.	Seminars, Micro-Projects, Research-Oriented Learning, ICT-Enabled Learning, Reflective Practices	CLO4
IV	Picard's Method of successive Approximations, Existence and uniqueness of solution of initial value problems of first order equation: Picard's theorem (statement only). System of first order equation: Homogeneous Linear system with constant coefficients, Critical points of an autonomous system and classification, Stability of linear systems with constant coefficients.	Seminars, Problem-Based Learning, Research-Oriented Learning, Inquiry-Based Learning, ICT-Enabled Learning	CLO5, CLO6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term test (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	15	1	2	9	12
II	CLO3	15	1	2	9	12
III	CLO4	15	1	3	9	13
IV	CLO5, CLO6	15	1	3	9	13
		60 (4Hrs/week)	4	10	36	50

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	2	-	-	2	1	-	1	-
CLO2	3	2	3	1	-	2	1	-	-	1
CLO3	3	3	2	-	-	2	1	-	-	-
CLO4	3	2	3	1	-	2	1	2	-	1
CLO5	3	3	2	-	1	2	1	-	1	-
CLO6	3	2	3	2	-	3	1	-	-	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Differential Equations with Applications and Historical Notes	G. F. Simmons	2nd Edition 1991	McGrow Hill
2	An Introduction to Ordinary Differential Equations	E. A. Coddington	1989	Dover Publications Inc.
3	Introduction to Ordinary Differential Equations	Rabenstein A. L	2nd Edition 1972	Academic Press
4	Advanced Differential Equations	Raisinghania M. D.	19th Edition 2018	S. Chand
5	Elements of Partial Differential Equations	Sneddon I. N.	1957	McGraw-Hill Publ. Co.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL course on "Ordinary Differential Equations"	https://nptel.ac.in/courses/111104031
2	NPTEL course on "Ordinary Differential Equations and Applications"	https://nptel.ac.in/courses/111108081

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S01NEMTH02**	Partial Differential Equations	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply Lagrange's, Charpit's, and Jacobi's methods to solve first-order partial differential equations.

CLO2: Analyse and solve Cauchy problems and compatible systems of first-order partial differential equations.

CLO3: Solve linear partial differential equations using operator methods *F(D,D')* for both homogeneous and non-homogeneous cases.

CLO4: Classify second-order partial differential equations and transform them into canonical forms for solution.

CLO5: Apply separation of variables to solve Laplace, Heat, and Wave equations in Cartesian and polar coordinates.

CLO6: Analyse and solve boundary value problems using Dirichlet and Neumann conditions, including uniqueness theorems and Poisson integral formula.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Solution of first order partial differential equation using Lagrange's method, non-linear first order partial differential equations: compatible system of first order partial differential equations, solution by Charpit's method and Jacobi's method, Cauchy problem for first order equation.	Seminars, Problem-Based Learning, ICT-Enabled Learning, Collaborative Learning	CLO1, CLO2
II	Linear partial differential equations with constant coefficients $F(D,D')z = f(x,y)$, where $f(x,y)$ is of the form $\varphi(ax+by)$, $F(D,D')$ is homogeneous and non- homogeneous, general method. Second order partial differential equations with variable coefficients: $F(xD,yD')z = f(x,y)$.	Seminars, Problem-Based Learning, Case-Based Learning, ICT-Enabled Learning	CLO3
III	Classification of second order partial differential equations and canonical form, nonlinear second order partial differential equations: Monge's	Seminars, Micro-Projects, ICT-Enabled Learning,	CLO4, CLO5

	method, special case and general case. Method of separation of variable: solution of three special equations – Laplace, Heat and Wave equations, solution of these equations in cartesian and polar coordinate systems.	Reflective Practices	
LIV	Boundary Value Problems (BVP): Maximum and minimum principles, Uniqueness theorem of Dirichlet problem, the Dirichlet interior problem for a circle, Poisson integral formula, the Dirichlet exterior problem for a circle, the Dirichlet problem for a rectangle, the Neumann problem for a circle.	Seminars, Research-Oriented Learning, ICT-Enabled Learning	CLO6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term test (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	15	1	3	9	13
II	CLO3	15	1	3	9	13
III	CLO4, CLO5	15	1	2	9	12
IV	CLO6	15	1	2	9	12
		60 (4Hrs/week)	4	10	36	50

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	3	1	1	2	1	–	1	1
CLO2	3	3	3	1	1	2	1	–	1	1
CLO3	3	2	3	2	2	2	1	–	1	2
CLO4	3	3	2	2	1	2	1	–	1	1
CLO5	3	2	3	3	2	2	1	1	1	2
CLO6	3	3	3	3	1	3	2	2	1	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Publisher	Edition/Year
1	Elementary Course in Partial Differential Equations	Amarnath T	2nd Edition 2003	Narosa Pub. House, New Delhi
2	Elements of Partial Differential Equations	Sneddon I. N.	1957	McGraw- Hill Pub. Co.
3	Partial Differential Equations	Phoolan Prasad, Ravindran Renuka	2022	New Age Int. Pub.
4	Advanced Differential Equations	Raisinghania M. D.	1995	S. Chand & Co.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL course on "Partial Differential Equations"	https://nptel.ac.in/courses/111101153
2	NPTEL course on "Partial Differential Equations"	https://nptel.ac.in/courses/111103021

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S01NEMTH03**	Graph Theory I	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Understand and apply fundamental concepts of graph theory, including connected graphs, trees, distance, diameter, Euler graphs, and graph isomorphism.

CLO2: Analyze graph coloring concepts such as chromatic number, chromatic partitions, uniquely colorable graphs, and compute chromatic polynomials, including understanding the significance of the Four-Color Problem.

CLO3: Apply matching theory concepts to solve problems involving maximum matching, Hall's condition, vertex cover, edge cover, independence number, and dominating sets.

CLO4: Evaluate connectivity properties of graphs, including vertex and edge connectivity, and determine conditions for the existence of Hamiltonian cycles.

CLO5: Interpret and analyze directed graphs, including their structure, connectivity, directed trees, and spanning in-trees and out-trees.

CLO6: Apply matrix representations (incidence, adjacency, and circuit matrices) of directed graphs and analyze Euler digraphs, fundamental circuits, and their applications.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Review of basic facts about graphs: connected graph, tree, distance and diameter, Euler graph, isomorphic graphs. Chromatic number, chromatic partitioning, uniquely colorable graphs, chromatic polynomial, Four-color Problem.	Seminars, Problem-Based Learning, Collaborative Learning, ICT-Enabled Learning, Inquiry-Based Learning	CLO1 CLO2
II	Matching and covers: maximum matching, Hall's matching condition, min-max theorems, independence number, vertex cover, edge cover, dominating set.	Seminars, Problem-Based Learning, Micro-Projects, Research-Oriented Learning, Collaborative Learning	CLO3
III	Cuts and Connectivity: Vertex connectivity and edge connectivity. Hamiltonian cycles: necessary conditions, sufficient conditions. Directed Graphs: Definitions and examples, some special types of digraphs, directed path and connectedness, trees with directed edges, spanning out-tree, spanning in-tree.	Seminars, Problem-Based Learning, Collaborative Learning, Flipped Classroom Approach, Inquiry-Based Learning	CLO4, CLO5

IV	Directed graphs (conti.): Euler digraph and its application, relation of spanning out-tree and spanning in-tree with Euler digraph, Incidence matrix A, Circuit matrix B and Adjacency matrix X of digraphs, Fundamental circuits and fundamental circuit matrix in digraphs.	Seminars, Research-Oriented Learning, ICT-Enabled Learning, Micro-Projects, Self-Directed Learning	CL05, CLO6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term Test (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	15	1	3	9	13
II	CLO3	15	1	3	9	13
III	CLO4, CLO5	15	1	2	9	12
IV	CLO5, CLO6	15	1	2	9	12
		60 (4Hrs/week)	**4**	**10**	**36**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	2	–	–	1	1	–	1	1
CLO2	3	3	2	–	–	2	1	–	1	1
CLO3	3	3	2	–	1	2	1	1	1	–
CLO4	3	3	3	1	–	2	2	–	1	1
CLO5	3	3	2	–	–	2	1	–	1	–
CLO6	3	3	3	1	–	3	1	1	1	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Graph Theory with applications to Engineering and Computer Science	Narsingh Deo	1974	Prentice-Hall of India Pvt. Ltd., New Delhi
2	Introduction to Graph Theory	Douglas B. West	2nd Edition 2007	Pearson Education, Inc.
3	A first look at graph theory	John Clark and D. A. Holton	1991	Allied Publishing Ltd.
4	Introduction to graph theory	Robin J. Wilson	4th Edition 1996	Addison Wesley Longman limited

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Introduction to Graph Theory Course by Dr. Prashantkumar Patel	https://youtu.be/SZ2zOZu-eoA?si=UgBOLg-4rKaV0dfX
2	Lecture notes on Graph theory-I by Dr. Prashantkumar Patel	https://sites.google.com/view/prashantkumarpatel/downloads/graph-theory-msc
3	NPTEL course on "Graph Theory"	https://nptel.ac.in/courses/111106050

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S01NEMTH04**	Number Theory	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply fundamental concepts such as division algorithm, GCD, and Euclidean algorithm to solve number-theoretic problems.

CLO2: Analyze and solve linear Diophantine equations and understand prime factorization using the Fundamental Theorem of Arithmetic.

CLO3: Apply congruence relations, Chinese Remainder Theorem, and Fermat's theorem to solve modular arithmetic problems.

CLO4: Investigate arithmetic functions such as divisor functions, Möbius function, and Euler's phi-function and their properties.

CLO5: Analyze advanced concepts like primitive roots, quadratic residues, Legendre symbol, and quadratic reciprocity.

CLO6: Formulate mathematical arguments and solve problems using rigorous proofs and computational techniques in number theory.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	The division algorithm, the greatest common divisor, the Euclidean algorithm, the Diophantine equation ax + by = c, the fundamental theorem of arithmetic, the sieve of Eratosthenes, the Goldbach conjecture	Seminars, Problem-Based Learning, Inquiry-Based Learning, ICT-Enabled Learning, Collaborative Learning	CLO1, CLO2, CLO6
II	Basic properties of congruence, binary and decimal representation of integers, linear congruences and the Chinese remainder theorem, Fermat's little theorem and pseudoprimes, Wilson's theorem.	Seminars, Problem-Based Learning, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning	CLO3, CLO6
III	The sum and number of divisors, the Möbius inversion formula, the greatest integer function, an application to the calendar, Euler's phi-function, Euler's theorem, some properties of the phi-function.	Seminars, Micro-Projects, Research-Oriented Learning, ICT-Enabled Learning, Reflective Practices	CLO4, CLO6

IV	The order of an integer modulo n, primitive roots for primes, Euler's criterion, Legendre's symbol and its properties, Quadratic reciprocity.	Seminars, Problem-Based Learning, Research-Oriented Learning, Inquiry-Based Learning, ICT-Enabled Learning	CLO5, CLO6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term test (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2, CLO6	15	2	4	7	13
II	CLO3, CLO6	15	2	4	7	13
III	CLO4, CLO6	15	2	3	7	12
IV	CLO5, CLO6	15	2	3	7	12
		60 (4Hrs/week)	**8**	**14**	**28**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	3	1	2	2	1	1	1	1
CLO2	3	3	3	1	2	2	1	1	1	1
CLO3	3	2	3	2	2	2	1	1	1	2
CLO4	3	3	2	2	2	3	1	1	2	2
CLO5	3	3	2	2	2	3	1	1	2	2
CLO6	3	3	3	2	2	3	2	2	2	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr No	Title	Author(s)	Edition/Year	Publisher
1	Elementary Number Theory	Burton David M.	7th Edition 2011	McGraw Hill Education
2	An Introduction to Theory of Numbers	Hardy G. H. and Wright E. M.	6th Edition 2008	Oxford University Press
3	An Introduction to the Theory of Numbers	Nivan Ivan, Zuckerman H. S. and Montgomery H. L.	5th Edition 1991	John Wiley & Sons Inc.
4	Introduction to Analytic Number Theory	Apostol Tom M.	2010	Springer

- **Online Resources (Open Source)**

Sr No	Description of Resource(s)	Weblink
1	MIT Lecture Notes & Assignments	https://ocw.mit.edu/courses/18-781-theory-of-numbers-spring-2012/download/
2	A Basic Course in Number Theory (IIT Bombay – NPTEL) by Prof. Shripad Garge	https://onlinecourses.nptel.ac.in/noc24_ma89/preview
3	Number Theory (IIT Guwahati – NPTEL Archive Course) by Prof. Anupam Saikia	https://nptel.ac.in/courses/111103020

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S01NEMTH05**	Mathematical Classical Mechanics	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Interpret constraints, generalized coordinates, and configuration space, and apply the principles of virtual work and D'Alembert's principle to formulate equations of motion for constrained systems.

CLO2: Derive and apply Lagrange's Equations of Motion (LEOM) for conservative, non-conservative, and mixed systems using the Lagrange's equations and solve relevant physical problems.

CLO3: Apply Hamilton's Principle to derive equations of motion and analyze classical problems such as the Brachistochrone problem.

CLO4: Construct the Hamiltonian for dynamical systems and use Hamilton's equations of motion to describe system evolution in phase space, including conservation laws.

CLO5: Analyze dynamical systems using canonical transformations, generating functions, compute Poisson brackets and Lagrange brackets to obtain equations of motion and formal solutions.

CLO6: Analyze small oscillations using normal coordinates and eigenvalue methods, extend Lagrangian and Hamiltonian formulations from discrete to continuous systems.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Constraints, Types of constraints, Generalized co-ordinates, Configuration space, Principle of virtual work, Lagrange's equations of Motion (LEOM) using D' Alembert's principle, LEOM for conservative system, LEOM for non-conservative system, LEOM for partly conservative and partly non-conservative system, appropriate examples.	Seminars, Problem-Based Learning, Inquiry-Based Learning, Collaborative Learning	CLO1, CLO2
II	Euler-Lagrange equations in various forms (without derivation), Hamilton variational principle, Brachistochrone problem, Derivation of LEOM from Hamilton's principle, generalized momentum, cyclic coordinates, energy function, conservation of linear momentum and angular momentum in Lagrangian formalism, Conservation of total energy, Hamiltonian for a dynamical system, Hamilton's equations of motion (HEOM), phase space, Hamilton's modified principle, derivation of HEOM from Hamilton's modified principle, appropriate examples.	Seminars, Research-Oriented Learning, Problem-Based Learning, ICT-Enabled Learning	CLO3, CLO4

III	Canonical transformations, generating functions, symplectic condition, infintesimal canonical transformations, examples, Poisson bracket, Lagrange bracket, formal solution of equations of motion in terms of Poisson brackets, appropriate examples.	Seminars, Inquiry-Based Learning, Problem-Based Learning, Collaborative Learning	CLO5
IV	Lagrangian for small oscillations, eigenvalue equation and the principal axis transformation, frequencies of free vibration and normal coordinates, free vibrations of a linear triatomic molecule, Transition from a discrete to a continuous system, the Lagrangian and Hamiltonian formulation for continuous system	Seminars, Problem-Based Learning Mini Research Tasks, ICT-Enabled Learning, Experiential Learning	CLO6

(A) Internal Assessment

a. Internal Formative assessment (20 Marks)

(i) Assignment (5 marks)
(ii) Seminar (5 marks)
(iii) Quizzes (5 marks)
(iv) Attendance (5 marks)

b. Internal Summative Assessment (30 Marks)

(i) Mid-term test (30 Marks)

(B) Weightage of Learning Efforts for External Assessment (50 Marks)

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	CLO1, CLO2	15	2	3	8	13
II	CLO3, CLO4	15	2	3	8	13
III	CLO5	15	1	2	9	12
IV	CLO6	15	1	2	9	12
		60 (4Hrs/week)	**6**	**10**	**34**	**50**

M.Sc. Mathematics Semester-I

- **Assessment and Evaluation**

Sr No	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	2	2	1	2	1	1	1	1
CLO2	3	3	3	2	2	2	1	1	1	2
CLO3	3	3	2	2	1	2	1	1	1	2
CLO4	3	3	3	2	2	2	1	1	1	2
CLO5	3	3	3	2	2	3	2	1	1	2
CLO6	3	3	3	3	2	3	2	1	1	3

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Classical Mechanics	Herbert Goldstein, Charles P. Poole and John L. Safko	3rd Edition 2011	Pearson Education, Inc.
2	Mathematical Methods of Classical Mechanics	V. I. Arnold	2nd Edition 1997	Springer-Verlag
3	Mechanics and Relativity	Vidwan Singh Soni	2nd Edition 2011	PHI Learning Pvt. Ltd.
4	Classical Mechanics	J. C. Upadhyay	2nd Edition 2014	Himalaya Publishing House
5	Classical Mechanics	Yeshwant R. Waghmare	1990	PHI Pvt. Ltd.

- **Online Resources (Open Source):**

Sr No	Description of Resource(s)	Weblink
1	NPTEL Course on Classical Mechanics	https://nptel.ac.in/courses/115105098
2	NPTEL Course on Classical Mechanics	https://nptel.ac.in/courses/115106123

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S01NEMTH06**	Riemann Integration	2-0-1	**60**	02

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply the definition of Riemann integral, partitions, and refinement of partitions to determine the integrability of real-valued functions on closed intervals.

CLO2: Analyze conditions for Riemann integrability using Darboux's Theorem and evaluate the algebra of integrable functions (sum, product, quotient, modulus).

CLO3: Apply the concept of Riemann sums and interpret definite integrals as limits of sums for various classes of functions.

CLO4: Analyze the relationship between integration and differentiation, including the concept of primitives and the conditions under which functions are integrable.

CLO5: Apply the Fundamental Theorem of Integral Calculus to evaluate definite integrals and solve problems involving accumulation and rate of change.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Riemann Integrals: Definitions and Existence, Inequalities for Integrals, Refinement of Partitions, Darboux's Theorem for Integrals, Conditions for Integrability, Integrability of the Sum, Difference, Product, Quotient and Modulus functions.	Seminars, Problem-Based Learning, Inquiry-Based Learning, ICT-Enabled Learning	CLO1, CLO2, CLO3
II	Integral as the limit of sums (Riemann Sums), Some Integrable functions, Integration and Differentiation, The Primitive, The Fundamental Theorem of Integral Calculus.	Seminars, Problem-Based Learning, Self-Directed Learning, ICT-Enabled Learning	CLO3, CLO4, CLO5

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (15 Marks)

(i) Quizzes (5 marks)
(ii) Seminar (5 marks)
(iii) Attendance (5 Marks)

b. Internal Summative Assessment (10 Marks)

(i) Mid-term test (10 Marks)

(B) Weightage of Learning Efforts for External Assessment (25 Marks)

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2, CLO3	15	1	3	9	13
II	CLO3, CLO4, CLO5	15	1	2	9	12
		30 (4Hrs/week)	**2**	**5**	**18**	**25**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Quizzes, Seminar, Attendance	50
2	End-Semester Examination	Written Exam	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	3	1	1	2	2	-	1	-
CLO2	1	3	3	1	1	3	2	-	1	-
CLO3	3	2	3	1	3	2	2	-	2	1
CLO4	1	3	3	3	1	3	2	-	2	2
CLO5	3	2	3	3	3	2	3	2	2	3
CLO6	3	3	3	1	1	2	2	-	1	-

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	A course in Calculus and Real Analysis	S. R. Ghorpade and B. V. Limaye	2006	Springer
2	Real Analysis	Dipak Chatterjee	2nd Edition 2012	Prentice-Hall India Pvt. Ltd., New Delhi
3	Principles of Real Analysis	S. C. Malik	5th Edition 2021	New Age International, New Delhi

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	MIT Open Courseware – Single Variable Calculus	https://ocw.mit.edu/courses/18-01sc-single-variable-calculus-fall-2010/

M.Sc. Mathematics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	**P2S01NEMTH07**	History of Indian Mathematicians - I	2-0-1	**60**	02

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Describe the life and major contributions of key Indian mathematicians such as Aryabhata, Bhaskara II, and Srinivasa Ramanujan across different periods.

CLO2: Explain fundamental mathematical ideas developed by ancient Indian scholars including Mahaviracharya and Sridharacharya in arithmetic, algebra, and geometry.

CLO3: Analyze the development of mathematical thought from ancient to early modern India, with special reference to the Kerala School of Mathematics and Astronomy.

CLO4: Apply selected concepts such as infinite series and algebraic techniques introduced by mathematicians like Madhava of Sangamagrama and Bhaskara II to solve problems.

CLO5: Evaluate and present the significance and global impact of contributions made by mathematicians such as Srinivasa Ramanujan and Bharati Krishna Tirtha in a structured format.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Work and Life of Ancient Indian Mathematicians: • Aryabhata (476-550 CE) • Varahmihir (505-587 CE) • Bhaskara I (600-680 CE) • Mahaviracharya (800–870 CE) • Sridharacharya (850–950 CE) • Bhaskara II (1114-1185 CE)	Seminars, Inquiry-Based Learning, Collaborative Learning, ICT-Enabled Learning	CLO1, CLO2
II	Work and Life of Medieval Indian Mathematicians: • Kerala School of Mathematics • Madhava of Sangamagrama (1340–1425 CE) • Parameshvara (c. 1360–1455 CE) • Damodara (15th century)	Seminars, Problem-Based Learning, ICT-Enabled Learning, Collaborative Learning	CLO3, CLO4, CLO5

M.Sc. Mathematics Semester-I

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (15 Marks)

(i) Quizzes (5 marks)
(ii) Seminar (5 marks)
(iii) Attendance (5 Marks)

b. Internal Summative Assessment (10 Marks)

(i) Mid-term test (10 Marks)

(B) Weightage of Learning Efforts for External Assessment (25 Marks)

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	CLO1, CLO2	30	2	3	8	13
II	CLO3, CLO4, CLO5	30	2	3	7	12
		60 (4Hrs/week)	**4**	**6**	**15**	**25**

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	1	1	-	-	-	1	3	1	2	1
CLO2	2	2	-	-	-	2	3	1	2	1
CLO3	-	3	2	-	-	1	3	1	2	1
CLO4	3	2	3	2	1	2	3	1	2	2
CLO5	-	1	-	-	-	2	3	2	2	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term Test, Assignment, Seminar, Quizzes, Attendance	50
2	End-Semester Examination	Written Exam	50

M.Sc. Mathematics Semester-I

- **Suggested Learning Materials Books:**

Sr No	Title	Author(s)	Edition/Year	Publisher
1	Mathematics in India	Kim Plofker	2009	Princeton University Press
2	A passage to infinity: Medieval Indian mathematics from Kerala and its impact	G. G. Joseph	2009	SAGE Publications
3	The crest of the peacock: Non-European roots of mathematics	G. G. Joseph	3rd Edition 2011	Princeton University Press
4	The man who knew infinity: A life of the genius Ramanujan	R. Kanigel	1991	Washington Square Press
5	Geometry in ancient and medieval India	T. A. Sarasvati Amma	1999	Motilal Banarsidass
6	Āryabhaṭīya of Āryabhaṭa	K. S. Shukla & K. V. Sarma (Trans.)	1976	Indian National Science Academy
7	Vedic mathematics	B. K. Tirthaji	1965	Motilal Banarsidass
8	Chalk and duster	P. C. Vaidya	1999	Gujarat University

- **Online Resources (Open Source):**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL Course on Mathematics in India - From Vedic Period to Modern Times	https://nptel.ac.in/courses/111101080