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-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S02NCMTH01**	Topology	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

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

CLO1: Apply concepts of topological spaces, bases, and subbases to construct and compare different topologies.

CLO2: Analyse subspace, product, box, and metric topologies and evaluate their structural differences through examples.

CLO3: Analyse neighbourhoods, closure, interior, boundary, limit points, and density to study set-theoretic properties in topological spaces.

CLO4: Apply continuity concepts and the Pasting Lemma to analyse functions and evaluate homeomorphisms with examples.

CLO5: Differentiate and evaluate spaces using countability and separation axioms (T_0–T_4) and related theorems.

CLO6: Classify spaces based on compactness and connectedness, applying key results such as compactness under continuity and product compactness

Unit	Course Content	Learning Pedagogies	CLO(s)
I	Topological spaces: definition and examples, basis, examples of topologies given by basis, subbasis, closed sets. Techniques of creating topologies: the subspace topology, the product topology on X × Y, subbasis and basis for the product topology on arbitrary product, definition of the box topology on arbitrary product, the metric topology.	Seminars, Problem-Based Learning, Inquiry-Based Learning, Collaborative Learning, ICT-Enabled Learning	CLO1 CLO2
II	Neighborhood of a point, closure of a set, interior of a set, limit points of a set (i.e., derived set), dense set, boundary of a set. Continuous functions, intrinsic continuity of certain canonical functions, Pasting lemma, homeomorphisms, properties of homeomorphisms, examples and non-examples of homeomorphism.	Seminars, Problem-Based Learning, Case-Based Learning, Research-Oriented Learning, ICT-Enabled Learning	CLO3 CLO4
III	Countability Axioms: first countable spaces, second countable spaces, separable spaces. Separation Axioms: T_0-spaces, T_1-spaces, T_2-spaces, T_3-spaces and regular spaces, T_4-spaces and normal spaces, Urysohn's lemma (statement only), Tietze extension theorem (statement only).	Seminars, Problem-Based Learning, Inquiry-Based Learning, Research-Oriented Learning, Collaborative Learning	CLO5

IV	Compactness: compact spaces, compact subspaces, finite intersection property, compact subspaces of the real line, compactness and continuity, compactness of a finite product, Tychonoff's theorem (statement only), classifying spaces by compactness, definition and examples of Lindelöf spaces – a countability axiom. Connectedness: connected spaces, totally disconnected spaces, connected subspaces of the real line, components, path-connectedness, classifying spaces by connectedness.	Seminars, Problem-Based Learning, Research-Oriented Learning, Micro-Projects, 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, CLO4	15	2	4	7	13
III	CLO5	15	2	3	7	12
IV	CLO6	15	2	3	7	12
		60 (4Hr/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	1	2	1	1	1	1
CLO2	3	3	3	2	1	2	1	1	1	1
CLO3	3	3	3	2	1	3	1	1	1	1
CLO4	3	3	3	2	1	2	1	1	1	2
CLO5	3	3	2	2	1	3	1	1	2	2
CLO6	3	3	3	3	1	3	1	1	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	General Topology for Beginners	Jay Mehta	2025	Cambridge University Press
2	Topology: A Core Course	Vikram Aithal and S. Kumaresan	2023	Techno World
3	Topology: A First Course	James R. Munkres	2003	Prentice Hall of India Pvt. Ltd
4	General Topology	S. Willard	2004	Dover Publication
5	General Topology, Graduate Texts in Mathematics	J. Kelley	1975	Springer-Verlag
6	Introduction to Topology and Modern Analysis	G. F. Simmons	1963	McGraw-Hill Co.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Dinesh Karia, *Point Set Topology An Experience of a Teacher*, Open Mathematics Notes Series of the American Mathematical Society, November 2020.	https://www.ams.org/open-math-notes/omn-view-listing?listingId=110864
2	"Topology" – YouTube video playlist by S. Kumaresan	https://youtube.com/playlist?list=PLDzvuf9Uf4FNo3wbYrSEilPptlXvzx6Ch&si=cyesgZMWzKLEB-CW
3.	Essentials of Topology (IIT Dhanbad) NPTEL course by Prof. S. P. Tiwari	https://onlinecourses.nptel.ac.in/noc25_ma60/preview

M.Sc. Mathematics Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S02NCMTH02**	Lebesgue Integration Theory	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

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

CLO1: Apply the concepts of algebra and σ-algebra of sets, Borel sets, and the structure of open sets in □ to analyze measurable set constructions.

CLO2: Analyze Lebesgue outer measure and Lebesgue measurable sets, and evaluate their properties including the existence of non-measurable sets.

CLO3: Apply the theory of Lebesgue measurable functions, including simple functions, approximation theorems, and key results such as Egoroff's Theorem and Lusin's Theorem.

CLO4: Evaluate Lebesgue integration for simple, bounded, and non-negative measurable functions, and apply fundamental convergence theorems such as Fatou's Lemma and Monotone Convergence Theorem.

CLO5: Analyze advanced integration results including Dominated Convergence Theorem, countable additivity, and continuity properties of the Lebesgue integral.

CLO6: Apply the concepts of bounded variation and absolute continuity to establish the Fundamental Theorem of Lebesgue Integration and compare Lebesgue and Riemann integrals.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	**Lebesgue Measurable Sets** Algebra and σ-algebra of sets; Borel σ-algebra and Borel sets in □; Structure theorem for open subsets of □; G_δ-sets and F_σ-sets; Lebesgue outer measure in □; Lebesgue measurable sets and Lebesgue measure on □; Basic results on Lebesgue measure; Non-Borel sets and Non-measurable sets in □;	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO1
II	**Lebesgue Measurable Functions** Simple function and its canonical form; Lebesgue measurable functions; Results on Lebesgue measurable functions; Relation between continuous and Lebesgue measurable functions; Continuity and Lebesgue measurability of monotone functions; Littlewood's three principles; Egoroff's Theorem; Simple Approximation Theorem; Lusin's Theorem;	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO2, CLO3

III	**Lebesgue Integration** Lebesgue integral of measurable simple functions and results; Lebesgue integral of bounded measurable functions over a measurable set E of finite measure and results; Bounded Convergence Theorem; Lebesgue integral of non-negative measurable functions; Fatou's Lemma; Monotone Convergence Theorem; Lebesgue integral of measurable functions $f : E \to [-\infty, +\infty]$; Lebesgue Dominated Convergence Theorem; Countable additivity and continuity of integration;	Seminars, Problem-Based Learning, Collaborative Learning, ICT-Enabled Learning	CLO4, CLO5
IV	**Differentiation and Lebesgue Integral** Functions of bounded variation and results; Jordan's Lemma on functions of bounded variation; Absolutely continuous functions and results; Properties of indefinite integrals of Lebesgue integral functions; Relation between indefinite integral and absolute continuity; Fundamental theorem of Lebesgue integral; Characterization of Riemann integral and Lebesgue integral; Comparison of Riemann integral and Lebesgue integral.	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	15	2	4	7	13
II	CLO2, CLO3	15	2	4	7	13
III	CLO4, CLO5	15	2	3	7	12
IV	CLO6	15	2	3	7	12
		60 (4Hr/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	2	–	–	1	1	–	1	–
CLO2	3	3	3	–	–	2	1	–	1	–
CLO3	3	3	3	–	2	2	1	1	–	–
CLO4	3	3	3	–	2	3	1	–	1	–
CLO5	3	3	3	–	2	3	1	–	1	–
CLO6	3	3	3	2	2	3	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	Real Analysis	Royden H. L. and Fitzpatrick P. M.	4th Edition 2010	Pearson
2	An Introduction to Measure and Integration	Rana I. K.	1997	Narosa Publication House, New Delhi
3	Introduction to Measure Theory	G. de Berra	1974	van-Nordstrand

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	MathOnline – Measure & Lebesgue Integral Notes	https://mathonline.wikidot.com/measure-theory

M.Sc. Mathematics Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2S02NCMTH03**	Rings and Fields	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

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

CLO1: Apply concepts of rings, ideals, divisibility, GCD, and prime elements in algebraic structures.

CLO2: Analyze factorization in integral domains, including Gaussian integers and the Unique Factorization Theorem.

CLO3: Apply polynomial ring theory, division algorithm, and standard irreducibility criteria.

CLO4: Analyze field extensions, including algebraic elements, degree, and splitting fields.

CLO5: Evaluate automorphisms of fields and determine fixed fields and the automorphism group G(K, F).

CLO6: Apply Galois theory to study normal extensions, Galois groups, and solvability of polynomials.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	**Euclidean Rings and Factorization** Recall rings and ideals, Euclidean rings, Principal ideal rings, Divisibility (a|b), Greatest Common Divisor (GCD), Units and associates, Prime and relatively prime elements, Unique Factorization theorem, Ring of Gaussian integers J[i], Fermat's theorem.	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO1, CLO2
II	**Polynomial Rings and Irreducibility** Polynomial rings, The division algorithm for polynomials, Irreducible polynomials, Polynomials over the rational field, Primitive polynomials, content of polynomial, monic polynomial, Gauss's Lemma, Eisenstein Criterion, Polynomial rings over commutative rings, Unique factorization domain, Reducibility tests (polynomials of degree 2 and 3), Mod p irreducibility test, Cyclotomic polynomials.	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning	CLO3
III	**Field Extensions** Extension fields, Degree of an extension, Finite extensions, Algebraic and transcendental elements, Degree of algebraic elements, Algebraic extension, Algebraic complex numbers, Roots of polynomials, Splitting fields, More about roots, Derivative of polynomial, Simple extensions.	Seminars, Problem-Based Learning, Collaborative Learning, Inquiry-Based Learning, ICT-Enabled Learning	CLO4

IV	**Galois Theory** Automorphisms of fields, Fixed field of a group of automorphisms, Automorphism group G(K,F), Field of rational functions in n variables over a field, Elementary symmetric functions, Field of symmetric rational functions over a field, Normal extensions, Galois group G(K,F), Fundamental Theorem of Galois Theory, Radical extensions, Solvable groups, Abel's Theorem.	Seminars, Problem-Based Learning, Collaborative 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	2	4	7	13
II	CLO3	15	2	4	7	13
III	CLO4	15	2	3	7	12
IV	CLO5, CLO6	15	2	3	7	12
		60 (4Hr/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	–	–	–	–	–	–	–
CLO2	3	3	2	–	–	–	–	–	–	–
CLO3	3	2	3	–	1	–	–	–	–	–
CLO4	3	3	2	–	–	2		–	–	–
CLO5	3	3	2	–	–	2	2	–	–	–
CLO6	3	3	3	–	–	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	Topics in Algebra	I. N. Herstein	2nd Edition 2006	John Wiley & Sons
2	Contemporary Abstract Algebra	J. A. Gallian	8th Edition 2013	Books/Cole Cengage
3	Abstract Algebra	D. S. Dummit and R. M. Foote	3rd Edition 2004	John Wiley & Sons
4	A First Course in Abstract Algebra	J. B. Fraleigh	7th Edition 2003	Addison Wesley

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL course on *Introduction to Rings and Fields* video lectures	https://nptel.ac.in/courses/111106131
2	NPTEL course on *Galois Theory* video lectures.	https://nptel.ac.in/courses/111101117

M.Sc. Mathematics Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S02NEMTH01**	Ordinary Differential Equations	4-0-1	**120**	04

Note: This course is same as the **"**PS1EMTHCW01 Ordinary Differential Equations" offered in Semester I. The students who have studied **"**PS1EMTHCW01 Ordinary Differential Equations" in Semester I shall not be offered this course.

- **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-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S02NEMTH02**	Partial Differential Equations	4-0-1	**120**	04
Note: This course is same as the "PS1EMTHCW02 Partial Differential Equations" offered in Semester I. The students who have studied "PS1EMTHCW02 Partial Differential Equations" in Semester I shall not be offered this course.					

- **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 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.	Seminars, Micro-Projects, ICT-Enabled Learning, Reflective Practices	CLO4, CLO5

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 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, 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-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S02NEMTH03**	Graph Theory I	4-0-1	**120**	04

Note: This course is same as the "PS1EMTHCW03 Graph Theory I" offered in Semester I. The students who have studied "PS1EMTHCW03 Graph Theory I" in Semester I shall not be offered this course.

- **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-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S02NEMTH04**	Number Theory	4-0-1	**120**	04
Note: This course is same as the **"**PS1EMTHCW04 Number Theory" offered in Semester I. The students who have studied **"**PS1EMTHCW04 Number Theory" in Semester I shall not be offered this course.					

- **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 (4Hr/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-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S02NEMTH05**	Mathematical Classical Mechanics	4-0-1	**120**	04
Note: This course is same as the **"**PS1EMTHCW05 Mathematical Classical Mechanics" offered in Semester I. The students who have studied **"**PS1EMTHCW05 Mathematical Classical Mechanics" in Semester I shall not be offered this course.					

- **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 (4Hr/week)	**6**	**10**	**34**	**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	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-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S02NEMTH06**	Riemann Integration	2-0-1	**60**	02
Note: This course is same as the **"**PS1EMTHCW21 Riemann Integration" offered in Semester I. The students who have studied **"**PS1EMTHCW21 Riemann Integration" in Semester I shall not be offered this course.					

- **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, and 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 (15 Marks)

(i) Mid-term test (15 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 (4Hr/week)	**2**	**5**	**18**	**25**

- **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	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-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSE	**P2S02NEMTH07**	History of Indian Mathematicians - I	2-0-1	**60**	02
Note: This course is same as the **"**PS1EMTHCW22 History of Indian Mathematicians - I" offered in Semester I. The students who have studied **"**PS1EMTHCW22 History of Indian Mathematicians - I" in Semester I shall not be offered this course.					

- **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

- **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-II

- **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