FACULTY OF SCIENCES

SYLLABUS
of
Master of Science (Mathematics)
(Semester: I -IV)

(Under Credit Based Continuous Evaluation Grading System)

Session: 2026-27

The Heritage Institution

KANYA MAHA VIDYALAYA
JALANDHAR
(Autonomous)

Master of Science (Mathematics)

Session: 2026-27

Programme Specific Outcomes

Upon successful completion of this course, students will be able to:

PSO1: Gain deep understanding of pure and applied mathematics including areas such as algebra, analysis, topology, and differential equations.

PSO2: Develop the ability to analyze complex mathematical problems and apply logical reasoning to find effective solutions.

PSO3: Acquire skills to conduct independent research, including problem formulation, literature review, methodology development, and result interpretation.

PSO4: Apply mathematical principles to real-world problems in science, engineering, economics, and technology.

PSO5: Use mathematical software (like MATLAB, Python, or R) for modelling, simulation, and problem solving.

PSO6: Integrate theoretical knowledge with practical applications through seminars, projects, and internships.

PSO7: Foster a mindset for critical thinking, innovation, and exploration of new mathematical ideas.

PSO8: Communicate mathematical ideas clearly and effectively, both orally and in written form, for academic and professional purposes.

PSO9: Demonstrate ethical behavior and responsibility in research, teaching, and professional activities.

PSO10: Prepare for lifelong learning and careers in academia, research, industry, teaching, or further specialized studies like Ph.D. in Mathematics.

KANYA MAHA VIDYALAYA, JALANDHAR (AUTONOMOUS)

SCHEME AND CURRICULUM OF EXAMINATION OF TWO YEAR DEGREE PROGRAMME

(Under Credit Based Continuous Evaluation Grading System) (CBCEGS)

Master of Science (Mathematics)

Semester-I

(Session 2026-27)

<table>
<tr><td colspan="11">Master of Science (Mathematics) Semester-I</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Title</td><td rowspan="2">Course Type</td><td rowspan="2">Hours Per Week L-T-P</td><td rowspan="2">Credits L-T-P</td><td rowspan="2">Total Credits</td><td colspan="4">Marks</td><td rowspan="2">Examination Time (in Hours)</td></tr>
<tr><td>Total</td><td>Th</td><td>P</td><td>CA</td></tr>
<tr><td>MMSL-1331</td><td>Real Analysis</td><td>C</td><td>4-1-0</td><td>4-1-0</td><td>5</td><td>100</td><td>70</td><td>-</td><td>30</td><td>3</td></tr>
<tr><td>MMSL-1332</td><td>Complex Analysis</td><td>C</td><td>4-1-0</td><td>4-1-0</td><td>5</td><td>100</td><td>70</td><td>-</td><td>30</td><td>3</td></tr>
<tr><td>MMSL-1333</td><td>Algebra-I</td><td>C</td><td>4-1-0</td><td>4-1-0</td><td>5</td><td>100</td><td>70</td><td>-</td><td>30</td><td>3</td></tr>
<tr><td>MMSL-1334</td><td>Mechanics-I</td><td>C</td><td>4-1-0</td><td>4-1-0</td><td>5</td><td>100</td><td>70</td><td>-</td><td>30</td><td>3</td></tr>
<tr><td>MMSL-1335</td><td>Mathematical Programming-I</td><td>C</td><td>4-1-0</td><td>4-1-0</td><td>5</td><td>100</td><td>70</td><td>-</td><td>30</td><td>3</td></tr>
<tr><td colspan="2">Student can opt any one of the following interdisciplinary courses. ID Course opted in Sem-I cannot be opted in Sem-III</td><td>IDE*</td><td>4-0-0</td><td>4-0-0</td><td>4</td><td>100</td><td>70</td><td>-</td><td>30</td><td>3</td></tr>
<tr><td colspan="5">TOTAL</td><td>25</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="5">IDEC-1101
IDEM-1362
IDEH-1313
IDEI-1124
IDEW-1275</td><td colspan="6">Communication Skills
Basics of Music (Vocal)
Human Rights and Constitutional Duties
Basics of Computer Applications
Indian Heritage: Contribution to the World
(Credits of these courses will not be added to SGPA)</td></tr>
</table>

C-Compulsory Course

*Optional (Credits of ID courses will not be added to SGPA)

KANYA MAHA VIDYALAYA, JALANDHAR (AUTONOMOUS)

SCHEME AND CURRICULUM OF EXAMINATION OF TWO YEAR DEGREE PROGRAMME

(Under Credit Based Continuous Evaluation Grading System) (CBCEGS)
Master of Science (Mathematics)
(Session 2026-27)

Master of Science (Mathematics) Semester-II										
Course Code	Course Title	Course Type	Hours Per Week L-T-P	Credits L-T-P	Total Credits	Marks				Examination Time (in Hours)
						Total	TH	P	CA	
MMSL-2331	Differential Equations	C	4-1-0	4-1-0	5	100	70	-	30	3
MMSL-2332	Integral Transforms and Integral Equations	C	4-1-0	4-1-0	5	100	70	-	30	3
MMSL-2333	Algebra-II	C	4-1-0	4-1-0	5	100	70	-	30	3
MMSL-2334	Mechanics-II	C	4-1-0	4-1-0	5	100	70	-	30	3
MMSL-2335	Mathematical Programming - II	C	4-1-0	4-1-0	5	100	70	-	30	3
TOTAL					25					

C-Compulsory Course

KANYA MAHA VIDYALAYA, JALANDHAR (AUTONOMOUS)
SCHEME AND CURRICULUM OF EXAMINATION OF TWO YEAR DEGREE PROGRAMME
(Under Credit Based Continuous Evaluation Grading System) (CBCEGS)
Master of Science (Mathematics)
Semester-III
(Session 2026-27)

Master of Science (Mathematics) Semester-III										
Course Code	Course Title	Course Type	Hours Per Week L-T-P	Credits L-T-P	Total Credits	Marks				Examination Time (in Hours)
						Total	TH	P	CA	
MMSL-3331	Linear Algebra	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-3332	Measure Theory	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-3333	Statistics-I	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-3334	Partial Differential Equations	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSD-3335	Project	C	0-0-8	0-0-4	4	100	-	70	30	3
Student can opt any one of the following interdisciplinary courses. ID Course opted in Sem-I cannot be opted in Sem-III		IDE*	4-0-0	4-0-0	4	100	70	-	30	3
TOTAL					20					
IDEC-3101 IDEM-3362 IDEH-3313 IDEI-3124 IDEW-3275					Communication Skills Basics of Music (Vocal) Human Rights and Constitutional Duties Basics of Computer Applications Indian Heritage: Contribution to the World (Credits of these courses will not be added to SGPA)					

C-Compulsory Course
*Optional (Credits of ID courses will not be added to SGPA)

KANYA MAHA VIDYALAYA, JALANDHAR (AUTONOMOUS)
SCHEME AND CURRICULUM OF EXAMINATION OF TWO YEAR DEGREE PROGRAMME
(Under Credit Based Continuous Evaluation Grading System) (CBCEGS)
Master of Science (Mathematics)
Semester-IV
(Session 2026-27)

Master of Science (Mathematics) Semester-IV										
Course Code	Course Title	Course Type	Hours Per Week L-T-P	Credits L-T-P	Total Credits	Marks				Examination Time (in Hours)
						Total	TH	P	CA	
MMSL-4331	Functional Analysis	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-4332	Topology	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-4333	Statistics-II	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-4334	Number Theory	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-4335	History of Mathematics in India	C	4-0-0	4-0-0	4	100	70	-	30	3
TOTAL					20					

C-Compulsory Course

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Real Analysis
Course Code: MMSL-1331
Course outcomes

After the completion of this course, students should be able to

CO 1: Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts of interior points, interior and closure, open set, closed set, derived set, closure of a set and compact set.

CO 2: Give argument related to Separated sets, connected sets, components, Convergence and completeness in metric spaces.

CO 3: Understand and derive proofs of mathematical theorems related to limit and continuity, continuity and compactness, continuity and connectedness and uniform continuity.

CO 4: Differentiate between sequence and series of functions and able to solve problems related to uniform convergence and differentiation and use the polynomials to approximate a function.

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Real Analysis
Course Code: MMSL-1331

Examination Time: 3 Hrs

LTP Max. Marks: 100
4 1 0 Theory: 70
CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Set Theory: Finite, countable and uncountable sets. Metric spaces; open balls, closed balls, open and closed sets, Neighborhood, limit points, interior points, interior and closure, k- cells, compactness of k-cells, Compact subsets of Euclidean space R^k,Perfect sets, The Cantor set.

Unit II

Separated sets, connected sets in a metric space, Connected subsets of real line, Components, Sequences in Metric Spaces: Convergent sequences (in Metric Spaces), subsequences, Cauchy sequences, Complete metric spaces, Cantor's Intersection Theorem.

Unit III

Baire's theorem, Banach contraction principle, Continuity: Limits of functions (in metric spaces) Continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic functions, Uniform Continuity.

Unit IV

Sequences and Series of functions: Discussion of main problem, Uniform Convergence, Uniform Convergence and Integration, Uniform Convergence and Differentiation, Equicontinuous families of functions, Arzela's Theorem, Weierstrass Approximation theorem.

Text Book:

Rudin, W., Principles of Mathematical Analysis (3rd Edition), Mc Graw-Hill Ltd Ch.2,Ch.3, (3.1-3.12), Ch.4, Ch.6, (6.1-6.22), 2017.

Reference Books:

1. Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw-Hill Ltd (App.1), pp 337-338, Ch.2 (9-13), 1963.
2. Narayan, S.,A course of Mathematical Analysis,S.ChandPublicationsLtd,2005.
3. Apostol, T.M., Mathematical Analysis 2nd Edition7.18(Th.7.30&7.31), Narosa Publication, 2002.
4. Malik, S.C. and Arora, S., Mathematical Analysis, New Age International Publisher, 2017.

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Complex Analysis
Course Code: MMSL-1332
Course Outcomes

CO1. Define a function of complex variable and carry out basic mathematical operations with complex numbers. State and prove the Cauchy Riemann Equation and use it to show that a function is analytic.

CO2.Understand the principle of analytic Continuation and concerned results, critical points and fixed points.

CO3.To understand the modulus of complex values functions and result regarding that and to develop manipulation skills in the use of Rouche's theorem,

CO4. Define singularities of a function, know the different types of singularities and be able to determine the points of singularities of a function.

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Complex Analysis
Course Code: MMSL-1332

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Functions of complex variables, continuity and differentiability. Analytic functions, Conjugate function, Harmonic function. Cauchy Riemann equations (Cartesian and Polar form). Construction of analytic functions, Complex line integral, Cauchy's theorem, Cauchy's integral formula and its generalized form.

Unit II

Cauchy's inequality. Poisson's integral formula, Morera's theorem. Liouville's theorem, Conformal transformations. Bilinear transformations. Critical points, fixed points, cross-ratio. Problems on cross-ratio and bilinear transformation, Analytic Continuation, Natural Boundary, Schwartz Reflection Principle.

Unit III

Power Series, Taylor's theorem, Laurent's theorem. Maximum Modulus Principle. Schwarz's lemma. Theorem on poles and zeros of meromorphic functions. Argument principle. Fundamental theorem of Algebra and Rouche's theorem.

Unit IV

Zeros, Singularities, Residue at a pole and at infinity. Cauchy's Residue theorem, Jordan's lemma.

Integration round Unit circle. Evaluation of integrals of the type $\int_{-\infty}^{\infty} f(x)dx$.

Text Book:

S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, New Delhi, Second Edition, 1995

Reference Books:

1. S. Narayan, Theory of Functions of a Complex Variable, S. Chand Co. Pvt. Ltd., New Delhi, Fourth Edition, 2009 (Scope as in Chapters: 3, 5, 7, 9, 11).
2. J. W. Brown and R. V. Churchill, Complex Variables and Applications, McGraw-Hill Education, New York, Eighth Edition, 2004 (Scope as in Chapters: 1, 2, 4, 5, 6, 7, 9).

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Algebra-I
Course Code: MMSL-1333
Course Outcomes

Upon completion of this course, students should be able to:

CO 1: Understand the importance of the algebraic properties with regard to working with various number systems, explain the significance of the notion of a normal subgroup, quotient group, and cyclic group.

CO 2: Know and recognize the concepts of homomorphism, isomorphism and automorphism and understand permutation group.

CO 3: Describe the structure of finite abelian group using Sylow's theorems.

CO 4: State the definitions Direct Products: External and Internal, its applications; Semi direct Products, Recognition Theorems on semi direct products.

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Algebra-I
Course Code: MMSL-1333

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Groups: Definition & examples, Subgroups, Normal subgroups and Quotient Groups, Lagrange's Theorem, Generating sets, Cyclic Groups.

Unit II

The Commutator subgroups, Homomorphism, Isomorphism Theorems, Automorphisms, inner Automorphisms, Permutation groups, the alternating groups, Simplicity of A_n, $n \geq 5$, Cayley's theorem.

Unit III

Structure of finite Abelian groups. Conjugate elements, class equation with applications, Cauchy's Theorem, Sylow's Theorems and their simple applications, Composition Series, and Jordan Holder Theorem, Solvable Groups.

Unit IV

Direct Products: External and Internal. Fundamental theorem of finite Abelian groups and its applications; Semi direct Products, Recognition Theorems on semi direct products.

TextBook:

Fraleigh, J.B, An Introduction to Abstract Algebra, Pearson Education Publication Ltd., 2008.

ReferenceBooks:

1 Herstein,I.N.,TopicsinAlgebra,WilleyEastern PublicationLtd.,1975.
2. Singh,S.and Zameeruddin,Q.,ModernAlgebra,Vikas PublicationPvt.Ltd.,2006.
3. Artin,M.,Algebra,Pearson India,2015.

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Mechanics-I
Course Code: MMSL-1334
Course Outcomes

After the successful completion of the course, the students will be able to

CO 1: Determine velocity and acceleration of a particle along a curve; differentiate between radial and transverse components. Apply knowledge of angular velocity in circular motion to explain natural physical process and related technological advances.

CO 2: Understand and define the concept of Newton's law of motion and identify situations from daily life that they can explain with the help of these laws. Define Work, energy, power, conservative forces, impulsive forces, uniform resisted motion, and simple harmonic motion. Solve complex problems related to projectile motion under gravity, constrained particle motion and angular momentum of a particle. Define cycloid and its dynamical properties.

CO 3: Manage to solve problems related to reciprocal polar coordinates, pedal coordinates and equation, apply Kepler's law of planetary motion and Newton's law of gravitation in real life problems.

CO 4: Understand the concept of moment of inertia of a rigid body rotating about a fixed point, Momental ellipsoid and coplanar distribution.

Master of Science (Mathematics)

Semester-I
Session: 2026-27
Course Title: Mechanics-I
Course Code: MMSL-1334

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. The question paper must contain 30% of the article/theory from the syllabus.

Unit I

Velocity and acceleration of a particle along a curve, Radial & Transverse components (plane motion). Relative velocity and acceleration. Kinematics of a rigid body rotating about a fixed point. Vector angular velocity, General motion of a rigid body, General rigid body motion as a screw motion. Composition of angular velocities. Moving axes. Instantaneous axis of rotation and instantaneous centre of rotation.

Unit II

Newton's laws of motion, work, energy and power. Conservative forces, potential energy. Impulsive forces, Rectilinear particle motion:- (i) Uniform accelerated motion (ii) Resisted motion (iii) Simple harmonic motion (iv) Damped and forced vibrations. Projectile motion under gravity, constrained particle motion, angular momentum of a particle. The cycloid and its dynamical properties.

Unit III

Motion of a particle under a central force, Use of reciprocal polar coordinates, pedal co-ordinates and equations. Kepler's laws of planetary motion and Newton's Law of gravitation. Disturbed orbits, elliptic harmonic motion

Unit IV

Moments and products of Inertia, Theorems of parallel and perpendicular axes, angular motion of a rigid body about a fixed point and about fixed axes. Principal axes, Kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid, equimomental systems, coplanar distribution.

Reference Books:

1. Chorlton, F,Text Book of Dynamics, CBS Publication ltd.,2002.
2. Loney, S.L.,An Elementary Treatise on the Dynamics of a Particle of rigid Bodies, Cambridge University Press, 2017.
3. Rutherford, D.E.:ClassicalMechanics, Oliver & Boydpublication,1951.
4. 2. D.E. Rutherford, Classical Mechanics, University Mathematical Texts, Oliver & Boyd Ltd., Edinburgh, 1964.

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Mathematical Programming-I
Course Code: MMSL-1335
Course Outcomes

After the successful completion of this course, students will be able to:

CO 1: Formulate and solve linear programming problems using the simplex method and artificial variable techniques.

CO 2: Analyze and solve dual problems, transportation problems, and apply the MODI method for optimal solutions.

CO 3: Model and solve assignment and traveling salesman problems; apply game theory to two-person zero-sum games.

CO 4: Apply integer and dynamic programming techniques to solve optimization problems, including branch-and-bound and Gomory methods.

Master of Science (Mathematics)
Semester-I
Session: 2026-27
Course Title: Mathematical Programming-I
Course Code: MMSL-1335

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. The question paper must contain 30% of the article/theory from the syllabus.

Unit I

The linear programming problem, properties of a solution to the linear programming problem, generating extreme point solution, simplex computational procedure, development of minimum feasible solution, the artificial basis techniques, a first feasible solution using slack variables, two phase and Big-M method with artificial variables.

Unit II

General Primal-Dual pair, formulating a dual problem, primal-dual pair in matrix form, Duality theorems, complementary slackness theorem, duality and simplex method, economic interpretation of duality, dual simplex method. General transportation problem, transportation table, duality in transportation problem, loops in transportation tables, LP formulation, solution of transportation problem, test for optimality, degeneracy, transportation algorithm (MODI method), time minimization transportation problem.

Unit III

Mathematical formulation of assignment problem, assignment method, typical assignment problem, the traveling salesman problem. Game Theory: Two-person zero-sum games, maximin-minimax principle, games without saddle points (Mixed strategies), graphical solution of 2 * n and m * 2 games, dominance property, arithmetic method of n * n games, general solution of m * n rectangular games.

Unit IV

Integer Programming: Gomory's all I.P.P. method, constructions of Gomory's constraints, Fractional cut method-all integer and mixed integer, Branch-and-Bound method, applications of integer programming. Dynamic Programming: The recursive equation approach, characteristics of dynamic programming, dynamic programming algorithm, solution of-Discrete D.P.P., some applications, solution of L.P.P. by Dynamic Programming.

Reference Books:

1. Gass, S. L. Linear Programming (Methods & Applications), John Wiley & Sons, 2014
2. Hadley, G. Linear Programming, addison Publisher, 1963.
3. Kambo, N.S. Mathematical Programming Technique Affiliated East West Press Pvt. Ltd. 2008.
4. Swaroop, K., Gupta, P. K., Manmohan. Operations Research, S. Chand & Sons.
5. Panneerselvam, R. Operations Research, PHI Publications, 2016

Semester-II

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Differential Equations
Course Code: MMSL-2331
Course outcomes

After the completion of this course, students should be able to

CO 1: Understand and apply methods for solving first-order differential equations, including Picard's method and conditions for existence and uniqueness of solutions.

CO 2: Solve first-order simultaneous differential equations using geometric methods and Pfaffian forms, with applications in thermodynamics.

CO 3: Analyze nonlinear differential equations using phase plane methods and stability theory, including Liapunov's method and chaotic systems.

CO 4: Solve boundary value problems including Sturm-Liouville type, using separation of variables and orthogonal function series expansions.

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Differential Equations
Course Code: MMSL-2331

Examination Time: 3 Hrs

LT P	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

ODEs with variables separated, Exact Equations, Picard's method of successive approximations, Lipschtiz condition, Convergence of the successive approximations, Non-local existence of solutions, approximations to and uniqueness of solutions, equations with complex valued functions.

Unit II

Ordinary Differential Equations of the first order: Surfaces and curves in three dimensions, simultaneous Differential Equations of the first order and the first degree in three variables, Methods of solution of $dx/P = dy/Q = dz/R$, Orthogonal trajectories of a system of curves on a surface, Pfaffian differential forms and equations, solution of Pfaffian differential equations in three variables, Caratheodory's theorem, Applications to thermodynamics.

Unit III

Non-linear differential equation and stability: The Phase plane, Linear systems, autonomous system and stability, almost linear systems, competing species, predator-prey equations, Liapunov's second method, periodic solutions and limit cycles, chaos and strange attractors; the Lorenz equations.

Unit IV

The occurrence of two-point boundary value problems, Sturm-Liouville boundary value problems, Non homogeneous boundary value problems, Singular Sturm-Liouville problems, Method of separation of variables: A Bessel series expansion, Series of orthogonal functions: Mean Convergence.

Reference Books:

1. Coddington, E.A. An Introduction to Ordinary Differential Equations, Courier Corporation, 1989. [Scope as in Ch. 5]
2. Sneddon, I.N. Elements of Partial Differential Equations, Courier Corporation, 2013. [Scope as in Ch. 1]
3. Boyce, W.E. and DiPrima, R.C. Elementary Differential Equations and Boundary Value Problems, John Wiley & Sons, 2001. [Scope as in Ch. 9, Ch. 11]

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Integral Transforms and Integral Equations
Course Code: MMSL-2332
Course Outcomes

CO1. Understand and apply concepts of orthonormal systems and Fourier series, including convergence and approximation techniques.

CO2. Apply Fourier and Laplace transforms to solve differential equations and analyze system behavior using transform properties.

CO3. Formulate and solve Volterra integral equations of the first and second kind, and relate them to linear differential equations.

CO4. Solve Fredholm integral equations using successive approximations, Neumann series, and specialized kernel methods.

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Integral Transforms and Integral Equations
Course Code: MMSL-2332

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Review of linear and inner product spaces, Norm, orthogonal and orthonormal systems, orthogonal projections and approximations, infinite orthonormal systems, Fourier series, complex Fourier series, pointwise convergence and Dirichlet's Theorem, Uniform convergence, Parseval's identity, Sine and cosine series, Differentiation and integration of Fourier series, Fourier series on other intervals.

Unit II

Fourier Transform: Definition, existence, and properties, Convolution theorem, Fourier transform of derivatives and Integrals, Inverse Fourier transform and Plancherel's identity, convolution, Applications to partial differential equations.

Laplace Transform: Definition, existence, and properties, Inverse Laplace transform, The Heaviside and Dirac Delta functions, Convolution theorem, Applications to linear differential equations.

Unit III

Volterra Equations: Integral equations and algebraic system of linear equations, Volterra equation L2 Kernels and functions. Volterra equations of first & second kind, Volterra integral equations and linear differential equations.

Unit IV

Fredholm equations: solutions by the method of successive approximations. Neumann's series, Fredholm's equations with Pincherte-Goursat Kernels.

Text Books:

1. Pinckus, A. and Zafrany, S. Fourier Series and Integral Transforms. Cambridge University Press, 1997.
2. Benarjea, S., Mandal, B. N. Integral Equations and Integral Transforms, Springer, 2023

Reference Books:

1. Tricomi, F.G. Integral Equations, Courier Corporation, 2012.
2. Kanwal, R. P. Linear Integral Equations, Springer & Science Business Media, 2013.
3. Mikhlin, S.G. Linear Integral Equations, Courier Dover Publications, 2020

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Algebra-II
Course Code: MMSL-2333
Course Outcomes

After passing this course, the students will be able to:

CO 1: State the definitions of ring, subring, ideal, ring homomorphism.

CO 2: State definitions of important classes of rings associated with factorization: Unique Factorization Domain, Principal Ideal Domain, and Euclidean Domains. Show that a given ring falls into one of these classes (or not). Relate these classes of rings to each other.

CO 3: Explain the notion of an extension of a field. State the definitions and examples of algebraic extension, finite extension, simple extension, separable extensions, splitting field and Galois extension. Identify in specific examples whether an extension satisfies one of these properties.

CO 4: Describe Galois field. Relate the concept of solvability by radicals to Galois groups and State the definition of constructible point, line and number. Relate constructability to field extension degrees.

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Algebra-II
Course Code: MMSL-2333

Examination Time: 3 Hrs

LT P	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Rings, Subrings, Ideals, Factor Rings, Homomorphism, Integral Domains. Maximal and prime ideals.

Unit II

The field of Quotients of an integral domain.Principal Ideal domains, Euclidean Rings. The ring of Gaussian Integers, Unique Factorization domains, Polynomial Rings, Gauss's theorem and irreducibility of a polynomial.

Unit III

Extension Fields: Finite and Infinite, Simple and Algebraic Extensions, Splitting fields: Existence and uniqueness theorem.

Unit IV

Separable and inseparable extensions, perfect fields, finite fields, Existence of GF(pn), construction with straight edge ruler and compass.

Text Books:

1. Herstein, I.N.: Topics in Algebra, Willey Eastern1975.
2. Fraleigh, J.B, An Introduction to Abstract Algebra, Pearson Education Publication Ltd., 2008.

Reference Books:

1. Singh,S.and Zameeruddin, Q. Modern Algebra, Vikas PublicationPvt.Ltd.,2006.
2. Bhattacharya, P.B.,Jain,S.K.,andNagpal,S.R.,BasicAbstractAlgebra,Ch-14(Sec.1-5), 1994.

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Mechanics – II
Course Code: MMSL-2334
Course Outcomes

On the Successful completion of this course, the students will be able to

CO 1: Define general motion of a rigid body, linear momentum of a system of particles, angular momentum of a system, use of centroid, moving origins and impulsive forces. Illustrate the laws of motion, law of conservation of energy and impulsive motion.

CO 2: Manage to solve Euler's dynamical equation for the motion of a rigid body about a fixed point and state the properties of a rigid body motion under no force.

CO 3: Understand the concept of generalized coordinates and velocities, virtual work, generalized forces and solve Lagrange's equation for a holonomic system and impulsive forces. Demonstrate the concept of Kinetic energy as a quadratic function of velocities and equilibrium configuration for conservative holonomic dynamical systems.

CO 4: Define linear functional. Use Euler's-Lagrange's equations of motion for single independent and single dependent variable. Recognize Brachistochrone problem, Hamilton's Principle, Principle of Least action, differentiate between Hamilton's Principle and the Principle of Least action. Find approximate solution of BVP using Rayleigh-Ritz Method.

Master of Science (Mathematics)
Semester-II
Session: 2026-27
Course Title: Mechanics -II
Course Code: MMSL-2334

Examination Time: 3 Hrs

LT P	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. The question paper must contain 30% of the article/theory from the syllabus.

Unit I

General motion of a rigid body, linear momentum of a system of particles. Angular momentum of a system, use of centroid , moving origins, impulsive forces. Problems in two-dimensional rigid body motion, law of conservation of Angular momentum, illustrating the laws of motion, law of conservation of energy, impulsive motion.

Unit II

Euler's dynamical equations for the motion of a rigid body about a fixed point, further properties of rigid body motion under no forces. Problems on general three-dimensional rigid body motion.

Unit III

Generalized co-ordinates and velocities, Virtual work, generalized forces. Lagrange's equations for a holonomic system and their applications to small oscillation. Lagrange's equations for impulsive forces. Kinetic energy as a quadratic function of velocities. Equilibrium configurations for conservative holonomic dynamical systems. Theory of small oscillations of conservative holonomic dynamical systems.

Unit IV

Linear functional, Extremal. Euler's - Lagrange's equations of single independent and single dependent variable. Brachistochrone problem, Extension of the variational method. Hamilton's Principle, Principle of Least action. Distinctions between Hamilton's Principle and the Principle of Least Action. Approximate solution of boundary value problems:- Rayleigh-Ritz Method.

Reference Books:

1. Chorlton,F.,TextBookofDynamics,CBSPublicationltd.,2002.
2. Elsgolts,L.,Differential equations and the calculus of variations, University Press of Pacific, 2003.
3. Gupta,A.S.,Calculus of Variation with Application,PHILearningPvt.Ltd.,1996.

Master of Science Mathematics
Semester-II
Session 2026-27
Course Title: Mathematical Programming-II
Course Code: MMSL-2335
Course Outcomes

Successful completion of this course will enable the students to:

CO 1: Understand and analyze basic queueing models, including M/M/1 and generalized birth-death processes.

CO 2: Apply multi-server queueing models and solve deterministic inventory control problems including EOQ and price break models.

CO 3: Formulate and solve replacement problems for deteriorating and failed equipment, including manpower planning.

CO 4: Develop and implement simulation models using Monte Carlo methods for systems like inventory, queues, and job sequencing.

Master of Science (Mathematics)
Semester-II
Session 2026-27
Course Title: Mathematical Programming-II
Course Code: MMSL-2335

Examination Time: 3 Hrs

LT P	Max. Marks: 100
4 1 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Queueing Theory: Introduction, Queueing System, elements of queueing system, distributions of arrivals, inter arrivals, departure and service times. Classification of queueing models, single service queueing model with infinite capacity (M/M/1): (∞ /FIFO), Queueing Models: (M/M/1): (M/M/1): (N/FIFO), Generalized Model: Birth-Death Process.

Unit II

(M/M/C): (∞/FIFO), (M/M/C) (N/FIFO), (M/M/R) (KIGD), Power supply model., Inventory Control: The inventory decisions, costs associated with inventories, factors affecting Inventory control, economic order quantity (EOQ), Deterministic inventory problems with no shortage and with shortages, EOQ problems with price breaks, Multi item deterministic problems

Unit III

Replacement Problems: Replacement of equipment/Asset that deteriorates gradually, replacement of equipment that fails suddenly, recruitment and promotion problem, equipment renewal problem.

Unit IV

Need of simulation, methodology of simulation. Simulation models, event- type simulation, generation of random numbers, Monte-Carlo simulation, simulation of inventory problems, queueing systems, maintenance problem, job sequencing.

Text Book:

Kambo, N.S. Mathematical Programming Technique Affiliated East West Press Pvt. Ltd. 2008.

Reference Books:

1. Hadley, G. Linear Programming, addison Publisher, 1963.
2. Panneerselvam, R. Operations Research, PHI Publications, 2016

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Linear Algebra
Course Code: MMSL-3331
Course Outcomes

After passing this course, the students will be able to:

CO1: Explain the concepts of vector spaces, subspaces, quotient spaces, basis, dimension, direct sums, and linear transformations.

CO2: Use matrix methods to represent linear transformations, perform elementary operations, determine rank, and solve systems of linear equations.

CO3: Analyze linear operators using eigenvalues, eigenvectors, polynomials, invariant subspaces, diagonalization, triangulation, and dual space concepts.

CO4: Apply inner product space techniques, orthogonality, adjoint operators, and the spectral theorem to study normal, self-adjoint, and unitary operators.

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Linear Algebra
Course Code: MMSL-3331

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Vector spaces, Subspaces, Quotient Spaces, Basis and Dimension Theorems, Sum of subspaces, Direct sum decompositions, Linear transformations, The Algebra of linear transformations.

Unit II

Matrices associated with linear transformations, effect of change of ordered bases on the matrix of linear transformation, Elementary matrix operations and Elementary matrices, Row rank, Column rank and their equality, system of linear equations.

Unit III

Eigen values and Eigen vectors of linear operators, Characteristic and minimal polynomials, companion matrix, subspaces invariant under linear operators, triangulation, Diagonalization, Linear Functionals, Dual Spaces and dual basis, the double dual.

Unit IV

Inner Product Spaces, The Gram-Schmidt Orthogonalization, Orthogonal Complements, The Adjoint of a linear operator on an inner product space, Normal and Self-Adjoint Operators, Unitary and Normal Operators, Spectral Theorem.

Text Book:
Friedberg, S.H., Insel, A.J. and Spence, L.E. Linear Algebra, Fourth Edition, Prentice Hall, 2003.

Reference Books:
1. Hoffman, K. and Kunze, R. Linear Algebra, Second Edition, Prentice Hall India Learning, 2015.
2. Lang, S. Linear Algebra, Third Edition, Springer-Verlag, 1987

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Measure Theory
Course Code: MMSL-3332
Course Outcomes

After passing this course, the students will be able to:

CO1: Explain the concepts of Lebesgue measure, measurable sets, Borel and Lebesgue σ-algebras, and important examples such as non-measurable sets and the Cantor set.

CO2: Analyze measurable functions through their properties, algebraic operations, pointwise limits, and approximation by simple functions.

CO3: Compute Lebesgue integrals in different stages and apply fundamental convergence results such as the Bounded Convergence Theorem, Fatou’s Lemma, and Monotone Convergence Theorem.

CO4: Apply advanced Lebesgue integration techniques and convergence theorems including Dominated Convergence, Vitali Convergence, and compare Riemann and Lebesgue integrability.

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Measure Theory
Course Code: MMSL-3332

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Review of the topology of real line, the extended real numbers, σ-algebra, Borel-algebra and Borel sets, Lebesgue Outer Measure, Measurable Sets and their properties, σ-algebra of Lebesgue measurable sets, Outer and Inner Approximation of the Lebesgue Measurable Sets, Countable additivity of Lebesgue measure, Continuity of measure, the Borel-Cantelli Lemma, Non-Measurable Sets, The Cantor set and The Cantor-Lebesgue function, Comparison of σ algebra of measurable sets and the Borel σ-algebra of subsets of real line.

Unit II

The motivation behind Lebesgue Measurable Functions, various Characterizations and Properties of Measurable functions: Sum, Product and Composition, Sequential Point-wise Limits and Simple Approximations to Measurable Functions, Littlewood's three Principles.

Unit III

Lebesgue Integral (Stage I): Lebesgue Integral of a simple function, Comparison of Riemann and Lebesgue Integral, linearity and monotonicity of Lebesgue integration. Lebesgue Integral (Stage II): Lebesgue Integral of a bounded measurable function over a set of finite measure, linearity, monotonicity, and additivity over domain of integration, The Bounded Convergence Theorem. Lebesgue Integral (Stage III): Lebesgue Integral of a measurable function of finite support, Lebesgue Integral of a non-negative measurable function, linearity, monotonicity, and additivity over domain of integration, Fatou's Lemma, The Monotone convergence Theorem.

Unit IV

Lebesgue Integral (Stage IV): The General Lebesgue Integral, the integral comparison test, linearity, monotonicity, and additivity over domain of integration, The Lebesgue Dominated Convergence Theorem, General Lebesgue Dominated convergence Theorem, Countable Additivity and Continuity of Integration. Uniformly integrable family of functions, The Vitali convergence Theorem. Characterizations of Riemann and Lebesgue integrability.

Text Book:

Royden, H.L. and Fitzpatrick, P. M, Real Analysis (Fourth Edition), Pearson Education Inc. New Jersey, U.S.A., (Scope as in Ch.1-6), 2010

Reference Book:

Rudin, W. Real and Complex Analysis, Mc-Graw Hill, 1987.

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Statistics-I
Course Code: MMSL-3333
Course Outcomes

After passing this course, the students will be able to:

CO1: Demonstrate understanding of probability laws, conditional probability, Bayes' theorem, and random variables through PMF, PDF, and CDF.

CO2: Examine multivariate random variables using joint, marginal, and conditional distributions, stochastic independence, transformations, expectations, moments, and moment generating functions.

CO3: Apply probabilistic inequalities, stochastic convergence, central limit theorems, and standard discrete probability distributions to solve theoretical and practical problems.

CO4: Analyze continuous probability distributions and employ regression and correlation techniques, including partial and multiple correlation, correlation ratio, and association of attributes.

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Statistics-I
Course Code: MMSL-3333

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:

Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Classical and axiomatic approach to the theory of probability, additive and multiplicative law of probability, conditional probability and Baye's theorem, Random variable, probability mass function, probability density function, cumulative distribution function

Unit II

Two and higher dimensional random variables, joint distribution, marginal and conditional distributions, Stochastic independence, function of random variables and their probability density functions, Mathematical expectations and moments, moment generating function and its properties.

Unit III

Chebyshev's inequality and its application, Stochastic convergence, central limit (Laplace Theorem, Linderberg-Levy's Theorem), Discrete Probability Distributions: Uniform, Binomial, Poisson, Geometric, Negative Binomial distributions.

Unit IV

Continuous probability distributions: Uniform, Exponential, Gamma, Beta, Normal distributions. Least square principle, correlation and linear regression analysis for bi-variate data with correlation coefficients, association of attributes.

Reference Books:

1. Hogg, R.V., Mckean, J.W. and Craig, A.T. Introduction to Mathematical Statistics, Pearson (2012).
2. Mukhopadhyay, P. Mathematical Statistics, Books & Applied Publishers, 2016.
3. Gun, A.M., Gupta, M.K. & Dasgupta B. An Outline of Statistical Theory Vol.-I., Word Press, 2016

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Partial Differential Equations
Course Code: MMSL-3334
Course Outcomes

After passing this course, the students will be able to:

CO1: Solve first-order partial differential equations using linear, nonlinear, and characteristic methods.

CO2: Apply advanced solution techniques such as Charpit's method, Jacobi's method, and compatible systems for first-order PDEs.

CO3: Analyze second-order PDEs arising in physics and solve them using characteristics and separation of variables.

CO4: Apply Laplace's equation and boundary value methods to study physical problems and equipotential surfaces.

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Partial Differential Equations
Course Code: MMSL-3334

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Partial Differential Equations (PDEs) of First Order: origin of first order partial differential equations, Cauchy problem of first order equations, Linear equations of the first order, Integral surfaces passing through a given curve, Surface orthogonal to a given system of surfaces, Nonlinear PDE's of first order, Cauchy Method of Characteristics.

Unit II

Compatible system of first order PDE's, Charpit's method, Special type of first order equations, Solutions satisfying given conditions, Jacobi's method, Applications of first order PDE's.

Unit III

Partial differential equations of the 2nd order: Origin of 2nd order equations, 2nd order equations in Physics, Higher order equations in Physics, Linear PDE's with constant and variable coefficients, Characteristics of equations in three variables, the solution of linear hyperbolic equations, separation of variables, Non-linear equations of the 2nd order.

Unit IV

Laplace's Equation: The occurrence of Laplace's Equation in Physics, Elementary solutions of Laplace equation, Families of Equipotential surfaces, Boundary Value Problems, Separation of Variables, Problems with axial symmetry, Kelvin's Inversion Theorem.

Text Book:
Sneddon, I.N. Elements of Partial Differential Equations, Courier Corporation, 2013.

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Project
Course Code: MMSD-3335
Course Outcomes

After passing this course, the students will be able to:

CO 1: To understand the basic framework of research process.

CO 2: To understand the primary characteristics of research and to identify various sources of information for literature review and data collection.

CO 3: To learn how to design a project and will be accustomed to work independently and confidently.

CO 4: To understand the formulation of Mathematical Problem based on real time applications.

Master of Science (Mathematics) Semester-III
Session: 2026-27
Course Title: Project
Course Code: MMSD-3335

The students will do project work primarily focusing on educational research for the resurgence of quality education as a whole through research practices.

To monitor the progression of the students, CP-I, MST, CP-II will be conducted accordingly. In end semester examination, students will be evaluated on the basis of presentation, viva-voce and project report as per examination policy of Kanya Maha Vidyalaya.

SEMESTER-IV

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Functional Analysis
Course Code: MMSL-4331
Course Outcomes

After passing this course, the students will be able to:

CO1: Explain normed linear spaces, Banach spaces, inequalities, convergence, completeness, and continuous linear transformations.

CO2: Analyze finite dimensional normed spaces, compactness, dual spaces, Hahn–Banach theorem, natural embedding, and reflexivity.

CO3: Apply major results of functional analysis such as the open mapping theorem, closed graph theorem, uniform boundedness principle, and operator concepts.

CO4: Use inner product and Hilbert space methods, including orthogonality, orthonormal sets, and conjugate spaces.

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Functional Analysis
Course Code: MMSL-4331

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Normed linear spaces, Banach spaces, subspaces, quotient spaces, Lp-spaces: Holder's and Minkowski's Inequalities, Convergence and Completeness, Riesz-Fischer Theorem, Continuous linear transformations, equivalent norms.

Unit II

Finite dimensional normed linear spaces and compactness, Riesz Theorem, The conjugate space N*. The Hahn-Banach theorem and its consequences. Natural imbedding of N into N**, reflexivity of normed spaces.

Unit III

Open mapping theorem, projections on a Banach space, closed graph theorem, uniform boundedness principle, conjugate operators.

Unit IV

Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets, the conjugate space H*.

Text Books :

1. Simmons, G.F. Introduction to Topology and Modern Analysis, Ch. 9 & 10 (Sections 52-55), McGraw Hill International Book Company, 1963.
2. Royden, H. L. and Fitzpatrik, P.M. Real Analysis, Ch 6 (Sections 6.1- 6.3), Macmillan Co., 1988.

Reference Books:

1. Limaye, V. B. Functional Analysis, New Age International Pvt. Limited, 2014.
2. Jain, P.K. and Ahuja, O.P. Functional Analysis, New Age International (P) Khalil Ahmed Ltd. Publishers,1995.

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Topology
Course Code: MMSL-4332
Course Outcomes

After passing this course, the students will be able to:

CO 1: Demonstrate knowledge and understanding of concepts such as open and closed sets, closure and boundary, Neighbourhood's and Neighbourhood system, bases and sub – bases for a topological space etc.

CO 2: Will understand the behaviour of Connectedness on real line, Sequential continuity at point, Homeomorphism and embedding in different topological spaces.

CO 3: Create new topological spaces by using product topologies.

CO 4: Know and understand the concepts related to separation axioms such as T0, T1 etc.

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Topology
Course Code: MMSL-4332

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Topological Spaces, Basic concepts, closure, interior, exterior and boundary of a set. Dense sets, Closure operator [Kuratowski function] and Interior operator. Neighbourhoods and neighbourhood system. Local bases, bases and sub – bases for a topological space. Convergence of a sequence. First and second countable spaces. Lindeloff spaces, Separable spaces. Sub-spaces, Hereditary properties.

Unit II

Separated sets, Connected sets, Connected and disconnected spaces, Connectedness on real line. Components, Locally connected space. Totally disconnected space, Continuous functions, Restriction and extension of a mapping. Sequential continuity at a point. Open and closed mappings. Homeomorphism and embedding. Topological properties.

Unit III

Product of two spaces, The product of n spaces. Base for a finite product topology. General product spaces. Sub-base and base for product topology. Productive properties.

Unit IV

Separation Axioms: T0, T1, T2–spaces. Regular spaces, T3–spaces, Normal spaces, T4–space. Tychonoff lemma, Urysohn lemma, Tietze extension theorem.

Text Book:

Munkres, J. R. Topology, Prentice Hall of India, (Indian reprint) (Scope as in Ch.1-5), 2007.

Reference Books:

1. Moore, T. O., General Topology (Chapter2to8), Prentice Hall India Learning, 1964.
2. Kelley, J. L., General Topology, Dover Publications Inc.,2017.
3. Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw Hill education, 2017.

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Statistics-II
Course Code: MMSL-4333
Course Outcomes

After passing this course, the students will be able to:

CO1: Explain sampling distributions such as chi-square, t-test, F-test, and distributions of sample statistics.

CO2: Analyze point estimators and apply hypothesis testing procedures including MP and UMP tests.

CO3: Apply likelihood methods and standard tests such as chi-square, t-test, F-test, and proportion tests.

CO4: Use ANOVA techniques for statistical analysis.

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Statistics-II
Course Code: MMSL-4333

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Sampling Distributions: Chi-square, t and F-distributions with their properties, distribution of sample mean and variance, distribution of order statistics and sample range from continuous populations.

Unit II

Point Estimation: Estimators, Properties of unbiasedness, consistency, sufficiency, efficiency, completeness, uniqueness, methods of estimation, Testing of Hypothesis: Null hypothesis and its test of significance, p-value simple and composite hypothesis, M.P. test, UMP test, BLUE

Unit III

Likelihood tests (excluding properties of Likelihood Ratio Tests), Applications of Sampling Distributions: Test of mean and variance in the normal distribution, Tests of single proportion and equality of two proportions, Chi-square test, t-test, F-test.

Unit IV

Analysis of variance, analysis of variance for one way and two-way classified data with one observation per cell.

Reference Books:

1. Hogg, R.V., Mckean, J.W. and Craig, A.T. Introduction to Mathematical Statistics, Pearson, 2012.
2. Hoel, P.G. Introduction to Mathematical Statistics, John Wiley & Sons, 1971.
3. Mukhopadhyay, P. Mathematical statistics, Books & Applied, 2016.
4. Gun, A.M., Gupta, M.K. & Dasgupta B. Fundamental of statistic, Vol. I, World Press Pvt. Ltd., 2013.
5. Gun, A.M., Gupta, M.K. & Dasgupta B. An outline of statistical theory, Vol. I, World Press Pvt. Ltd, 2016.
6. Gupta, S. C., Kapoor, V. K. Fundamentals of Mathematical Statistics, S. Chand & Sons

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Number Theory
Course Code: MMSL-4334
Course Outcomes

After passing this course, the students will be able to:

CO1: Students will be able to solve simultaneous linear congruences using the Chinese Remainder Theorem and analyze properties of integers modulo n, including primitive roots and related theorems.

CO2: Students will be able to evaluate quadratic residues using Euler’s criterion, Legendre and Jacobi symbols, and apply the law of quadratic reciprocity to solve number-theoretic problems.

CO3: Students will be able to apply arithmetic functions and Mobius inversion to solve problems, and analyze Diophantine equations including representations as sums of squares.

CO4: Students will be able to use Farey sequences and continued fractions to approximate irrational numbers and solve Pell’s equation, including finding its fundamental solution.

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: Number Theory
Course Code: MMSL-4334

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Simultaneous Linear Congruence's, Chinese Remainder theorem with applications, Wolsten Holme's theorem, Lagrange's proof of Wilson theorem, Fermat numbers, The order of an integer modulo n. Primitive roots, Existence and number of primitive roots.

Unit II

Indices and their applications, Quadratic residues, Euler's criterion, Product of quadratic residues and quadratic non-residues, The Legendre symbol and its properties, Gauss's Lemma, Quadratic reciprocity law, Jacobian symbol and its properties.

Unit III

Arithmetic functions $\tau(n)$, σ (n), $\boldsymbol{\sigma_k}$ (n), $\mu(n)$, Perfect numbers, Mobius inversion formula, Diophantine equation $\boldsymbol{x^2 + y^2 = z^2}$ and its applications to $\boldsymbol{x^n + y^n = z^n}$. when n = 4. Criterion for an integer to be expressible as sum of two squares and sum of four squares.

Unit IV

Farey series, Farey dissection of a circle and its applications to approximations of irrationals by rationals, Finite and Infinite simple continued fractions, periodic and purely periodic continued fractions, Lagrange's Theorem on periodic continued fractions. Applications to Pell's equation. The fundamental solution of Pell's equation

Text Books:
Burton, D. M. Elementary Number Theory, McGraw Hill Education, 2017.

Reference Books:
1. Hardy, G.H. and Wright, E.M. An Introduction to the Theory of Numbers, Oxford University Press, 2008.
2. Niven, I., Zuckerman, S.H. and Montgomery L.H. An introduction to number theory, Wiley Publication, 2008.

Master of Science (Mathematics) Semester-IV
Session: 2026-27
Course Title: History of Mathematics in India
Course Code: MMSL-4335
Course Outcomes

After passing this course, the students will be able to:

CO1: Demonstrate understanding of the geometric, mensurational, and trigonometric contributions of ancient Indian mathematicians, particularly those found in the Shulbasutras and later classical texts.

CO2: Examine arithmetic, combinatorial, and recreational mathematical techniques in Indian mathematics, including number properties, series identities, Virahanka sequence, Kaprekar numbers, and magic squares.

CO3: Analyze classical Indian algebraic methods for linear, quadratic, higher degree, and indeterminate equations, with special emphasis on Kuttaka and Chakravala methods.

CO4: Appreciate the Kerala School's contributions to infinite series, trigonometric expansions, and early ideas of differential and integral calculus.

Master of Science (Mathematics) Semester-IV
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Course Code: MMSL-4335

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 0 0	Theory: 70
	CA: 30

Instructions for the paper setters/examiners:
Eight questions of equal marks (14 marks each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from Units I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

Unit I

Geometry in Shulbasutras [Ref. 2, Chapter-II]: Theorem of the square of the diagonal (Baudhayan, and Katyayan), Construction of geometrical figures in Shulbasutras (Squares, rectangles, trapezia, isosceles triangle equal in area to the given square and vice versa, rhombus of given area), Area preserving transformations of figures (Squaring the circle and circling the square, Rectangle to square and converse, rectangle or square into trapezium, trapezium into equivalent rectangle, rhombus into rectangle), Construction by the combination and subtraction of areas. The radius of Khavrita; hypotenuse of the right-angled triangle formed by Gnomon of shadow, Geometric proof of the sum of first n odd numbers. Brhamgupt's formula of a cyclic quadrilateral with Heron's formula as the special case. Proof of the relation between the Area and the Circumference of the circle by Neelkanth Somya ji, by the summation of Infinitesimals. Area and volume (Tetrahedron, Frustum, Cone, Pyramid, Sphere) problems by Araybhatt-I, Brahmagupt, and Bhaskar-II. The surface area and the volume of the sphere with early integration attempt in Yukti Bhasa. [Ref. 1, Ref. 2, Chapter V, VIII.] Origin of the term sine and cosine from Jya and Kotijya. Methods of constructing sine (Jya) by forming triangles and quadrilaterals in the quadrant of a circle. Yukti Bhasha proof of trigonometric identities. [Ref. 1, Ref. 2 Chapter V.]

Unit II

Mathematical Analysis of the methods developed by Bharti Krishna Tirtha: Divisibilty, squares and square roots, cubes and cube roots, and their theoretical proofs [Ref. 3, Chapter II]. Comparison of the methods developed for same by Aryabhatta, Sridhara, and Bhaskara-II. Varsankalita of Narayan Pandit (Sum of sums of natural numbers, sum of sums of terms in A.P., and extensions of Virahaṅka sequence, the so-called Fibonacci sequence, Representation of any number as a sum of Virahaṅka numbers, Super Golden ratio). Some identities related to the sum of series given by Sridhar, Mahavir, Thakkar Pheru, and Narayan Pandit with reference to Patiganit, Ganitasarasangraha, Ganitasarakaumudi, and Ganit Kaumudi. Kaprekar constant and convergence to Kaprekar constant, Kaprekar's swayambhu number, and their properties, Kaprekar's Harshad and Demlo numbers, Extension of Kaprekar's numbers to polynomials and other bases. Bhadraganit: Construction of magic squares, Pandiagonal magic squares, Sarvatobhadra of Varahamihira, Alpashruti, and Turgagati methods of Narayana Pandita. Classifications for magic squares with reference to Ganitasarasakaumudi of Thakkar Pheru (Even, odd, and evenly odd magic squares), and their construction.

Unit III

Linear equations in one variable, rules of false position, Bhaskar's method of operations with optional numbers. Aryabhatt's & Brahmgupt's method of division of differences. Linear equations with several unknowns (rules of Brahmagupt, Mahavir, and Bhaskar). [Ref. 1. Vol-II, Chapter. 7]

Quadratic equations (rules of Aryabhtt-I, Brahmagupt, Aryabhatt-II, Sridhar, Mahavir, Sripati, and Bhaskar-II). Solutions of equations of higher degrees and simultaneous quadratic equations by Bhaskar and Mahavir. One linear equation with more than two unknowns, Simultaneous Indeterminate equations of the first degree. Pulverisation (Kuttak) method. Solution of Brahmgupt-Bhaskar equation (The so-called Pell's equation) of the type Nx2± c=y2. Bhavana lemmas of Brahmagupt. Chakraval method of Bhaskar-II, Continued Fractions. [Ref. 3, Chapter-III], Single Indeterminate equations of higher degrees.

Unit IV

Madhav's infinite series for inverse tangent and $\pi/4$ (The so called Gregory-Leibnitz series). Madhav's infinite series for sine and cosine. Proof by Neelkanth Somyaji in Yukti-Bhasha and early attempts of integral Calculus with reference to the Kerala School of Mathematics. Rapidly converging series, Madhav's formulae for remainder terms.

Text Books:

1. Datta, B., & Singh, A. N. History of Hindu Mathematics: A Source Book, Vol-I, II, Gyan Prakashan, 2021. (First Published 1938, Lahore).
2. A. Saraswati, T. A. Geometry in Ancient and Medieval India: Motilal Banarsidass Publishers Private Limited, 2017. (First Edition 1979).
3. Bhanu Murthy, T. S. A modern Introduction to Ancient Indian Mathematics, New Age International Publishers, 2009 (First Edition 1992).
4. Parameshwaran, S. The Golden Age of Indian Mathematics, Swadeshi Science Movement, Kerala, 1998.
5. SaKHYa. Ganitasarakaumudi The Moonlight of the Essence of Mathematics by Thakkura Pheru, MANOHOR. 2009.

Reference Books:

1. Hayashi, T. Indian Mathematics.
2. Plofker, K. Mathematics in India.
3. Joseph, G. G. The Crest of the Peacock: Non-European Roots of Mathematics.
4. Sarma, K. V. &Ramasubramanian, K. Ganita-Yukti-Bhasha of Jyesthadeva.
5. Introduction to Indian Knowledge system, Concepts and Applications.**
6. Kamble, B. The Imperishable seed, Garuda Prakashan Pvt. Ltd., 2022.
7. Clark, W. E. The Aryabhatiya of Aryabhata, An ancient Indian work on Mathematics and Astronomy, D. K. Printworld, 2018 (First Published 1930)