FACULTY OF SCIENCES

SYLLABUS
of

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

(Under Credit Based Continuous Evaluation Grading System)

Session: 2025-26

The Heritage Institution

KANYA MAHA VIDYALAYA
JALANDHAR
(Autonomous)

Master of Science (Mathematics)

Session: 2025-27

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 2025-27)

Master of Science (Mathematics) Semester-I

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-1331	Real Analysis	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-1332	Complex Analysis	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-1333	Algebra-I	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-1334	Mechanics-I	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-1335	Mathematical Programming-I	C	4-0-0	4-0-0	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					

IDE Course Code	Course Title
IDEC-1101	Communication Skills
IDEM-1362	Basics of Music (Vocal)
IDEH-1313	Human Rights and Constitutional Duties
IDEI-1124	Basics of Computer Applications
IDEW-1275	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)

(Session 2025-27)

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	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-2332	Integral Transforms and Integral Equations	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-2333	Algebra-II	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-2334	Mechanics-II	C	4-0-0	4-0-0	4	100	70	-	30	3
MMSL-2335	Mathematical Programming -II	C	4-0-0	4-0-0	4	100	70	-	30	3
TOTAL					20	500				

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)
(Session 2024-2026)

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	Functional Analysis	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-3332	Partial Differential Equations and Integral Equations	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL3333	Operational Research-I	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-3334	Statistics-I	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSD-3335	Project	C	0-0-12	0-0-6	6	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					30	500				
IDEC-1101 IDEM-1362 IDEH-1313 IDEI-1124 IDEW-1275					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)
(Session 2024-2026)

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	Graph Theory	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-4332	Topology	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-4333	Operational Research-II	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-4334	Statistics-II	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-4335	Integral Transforms and Integral Equations	C	6-0-0	6-0-0	6	100	70	-	30	3
TOTAL					30	500				

C-Compulsory Course

Master of Science (Mathematics)
Semester-I
Session: 2025-27
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: 2025-27
Course Title: Real Analysis
Course Code: MMSL-1331

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

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: 2025-27
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: 2025-27
Course Title: Complex Analysis
Course Code: MMSL-1332

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

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: 2025-27
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: 2025-27
Course Title: Algebra-I
Course Code: MMSL-1333

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

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: 2025-27
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: 2025-27
Course Title: Mechanics-I
Course Code: MMSL-1334

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. 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: 2025-27
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: 2025-27
Course Title: Mathematical Programming-I
Course Code: MMSL-1335

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. 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: 2025-27
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: 2025-27
Course Title: Differential Equations
Course Code: MMSL-2331

Examination Time: 3 Hrs

LT P	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

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: 2025-27
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: 2025-27
Course Title: Integral Transforms and Integral Equations
Course Code: MMSL-2332

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 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: 2025-27
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: 2025-27
Course Title: Algebra-II
Course Code: MMSL-2333

Examination Time: 3 Hrs

LT P	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

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(p^n), 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: 2025-27
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: 2025-27
Course Title: Mechanics -II
Course Code: MMSL-2334

Examination Time: 3 Hrs

LT P	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. 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 2025-27
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 2025-27
Course Title: Mathematical Programming-II
Course Code: MMSL-2335

Examination Time: 3 Hrs

LT P — 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

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.

ReferenceBooks:

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

SEMESTER-III

Master of Science (Mathematics)
Semester-III
Session: 2024-26
Course Title: Functional Analysis
Course Code: MMSL-3331
Course Outcomes

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

CO 1: Understand the concept of normed linear spaces like,$L^{P(n)} l$(infinite), quotient and LP-spaces.

CO 2: Recognize the examples related to Finite dimensional normed linear spaces and compactness, conjugate space N* and understand The Hahn-Banach theorem and its consequences.

CO 3: Demonstrate the open mapping theorem, closed graph theorem and uniform bounded principal.

CO 4: Describe the concept of Inner product spaces, Hilbert spaces, orthogonal complements, orthonormal sets, the conjugate space H*.

Master of Science (Mathematics)
Semester-III
Session: 2024-26
Course Title: Functional Analysis
Course Code: MMSL-3331

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 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, L^p-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 toTopology and ModernAnalysis,Ch.9&10(Sections52-55), McGraw Hill International Book Company,1963.
2. Royden, H. L., and Fitzpatrik, P.M.,Real Analysis,Ch6 (Sections 6.1-6.3), Macmillan Co., 1988.

Reference Books:

1. Limaye,V.B.,FunctionalAnalysis,NewAgeInternationalPvt.Limited,2014.
2. Jain,P.K.andAhuja,O.P.,FunctionalAnalysis,NewAgeInternational(P)KhalilAhmed Ltd. Publishers,1995.

Master of Science (Mathematics)
Semester-III
Session: 2024-26

Course Title: Partial Differential Equations and Integral Equations
Course Code: MMSL-3332
Course Outcomes

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

CO 1: Perform various methods to solve homogeneous partial differential equations and apply Charpit method in solving problems.

CO 2: Use computational tools to solve Non homogeneous linear P.D.E. with constant coefficients, reducible and irreducible linear P.D.E. with constant coefficients, method of finding the complementary function and particular integral.

CO 3: Understand concept of Integral equations, Volterra Integral Equation of first and second kind and to find their solution using various techniques.

CO 4: Identify Fredholm Integral Equation and to find its solution using method of successive approximations. They will be able to find solution of a Fredholm Integral Equation with Separable Kernel.

Master of Science (Mathematics)
Semester-III
Session: 2024-26

Course Title: Partial Differential Equations and Integral Equations
Course Code: MMSL-3332

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 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 of First Order: origin of first order partial differential equations. Cauchy problem of first order equations. Integral surface through a given curve. Surface orthogonal to given system of surfaces. Non linearp.d.e of first order, Charpit's method and Jacobi's method. Partial differential equations of the 2nd order. Origin of 2nd order equations. Linear p.d.e. with constant coefficients and their complete solutions.

Unit II

Second order equation with variable coefficient and their classification and reduction to standard form. Solution of linear hyperbolic equation. Non-linear equations of second order, Monge's Method. Solution of Laplace, wave and diffusion equations by method of separation of variables and Fourier transforms. Green function for Laplace, waves and diffusion equation.

Unit III

Volterra Equations: Integral equations and algebraic system of linear equations. Volterra equation L2 Kernels and functions. Volterra equations of first & second kind. Volterraintegral 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 Kernel's, The Fredholm theorem.

Reference Books:

1. Piaggio,H.T.H.,Differentialequations,C.B.S.Publications,2004.
2. Tricomi,F.G.,Integralequation(Ch.IandII),DoverPublications,1985.
3. Kanwal.R.P.,Linearintegralequations,BirkhauserPublication,1996.
4. Sneddon,I.N.,Elementsofpartialdifferentialequations,DoverPublications,2006.
5. Levitt,W.W.,IntegralEquations,DoverPublications,2014.
6. Mikhlin,S.G.:IntegralEquations,Doverpublications,2020.

Master of Science (Mathematics)
Semester-III
Session: 2024-26

Course Title: Operational Research-I
Course Code: MMSL-3333
Course Outcomes

After studying this course students will be able to:

CO 1: Identify and develop operational research models from the verbal description of the real system and mathematical tools that are needed to solve optimization problems. They will be able to differentiate feasible, basic feasible and optimum solution of a linear programming problem and Plan optimum allocation of various limited resources such as men, machines, material, time, money etc. for achieving the optimum goal.

CO 2: Plan, forecast and make rational decisions and construct linear programming and integer linear programming models. They will be able to identify the situations where integer linear programming models are desirable and discuss the solution techniques and applications of linear programming. Understand and apply the Duality concepts to find the solutions of the primal problem and the relationship between the primal and dual linear programming problems.

CO 3: Analyze the transportation and assignment problems and solve those using mathematical models. They will become able to handle cases of unequal supply and demand, unacceptable routes etc. for a transport problem and become familiar with the types of problems such as travelling salesman problem that can be solved by applying an assignment model.

CO 4: Solve Zero Sum games, games without saddle points, graphical solution of 2*n and m*2 games. Able to understand approach of Dynamic Programming and find the solution of LPP Using Dynamic Programming.

Master of Science (Mathematics)
Semester-III
Session: 2024-26

Course Title: Operational Research-I
Course Code: MMSL-3333

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 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. The students can use only Non-Programmable & Non-Storage Type Calculator. 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, 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.

Unit III

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. Mathematical formulation of assignment problem, assignment method, typical assignment problem, the travelling salesman problem.

Unit IV

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.

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.

Text Book:

K. Swarup, P.K. Gupta and M. Mohan, Operations Research, Sultan Chand & Sons, New Delhi, 19th edition, 2017. (Scope as in chapters 1, 2, 4, 5, 7, 10, 11, 13, 17)

Reference Books:

1. N.S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi, 2005.
2. S.D. Sharma, Operations Research, Kedar Nath Ram Nath, Merrut,15th edition, 2010

3. H.A. Taha, Operations Research, Pearson Education Limited, England, 10th edition, 2017.

Master of Science (Mathematics)
Semester-III
Session: 2024-26

Course Title: Statistics-I
Course Code: MMSL-3334
Course Outcomes

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

CO 1: Distinguish between different types of data and interpret examples of methods for summarizing data sets, including common graphical tools such as histogram and summary statistics such as mean, median, mode, variance skewness and kurtosis. Further student will understand the basic concepts and applications of probability in real life scenarios

CO 2: Contrast between discrete and continuous random variable and apply general properties of expectations and variance.

CO 3: Compute probabilities for discrete and continuous distributions.

CO 4: Understand and interpret the knowledge regarding correlation of variables in real time data.

Master of Science (Mathematics)
Semester-III
Session: 2024-26

Course Title: Statistics-I
Course Code: MMSL-3334

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 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. The students can use only Non Programmable& Non Storage Type Calculator and statistical tables.

Unit I

Measures of Central tendency and dispersion, Moments, Measures of skewness and kurtosis. Classical and axiomatic approach to the theory of probability, Additive and multiplicative law of probability, Conditional probability and Bayes' 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 Linder berg, Levy's Theorem). Discrete Probability Distributions: Bernoulii, Binomial, Poisson, Negative Binomial, Geometric Distribution (For distributions only Mean, Variance, Moment Generating Function).

Unit IV

Continuous probability distributions: Uniform, Normal, Gamma, Beta, Exponential distributions (For distributions only Mean, Variance, Moment Generating Function). Least square principle, Correlation and linear regression analysis for bi-variate data. Theory of attributes: Independence of attributes, association of attributes.

Text Book:

S.C. Gupta and V.K Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 11th edition, 2019 (Scope as in chapters 2-11, 13).

Reference Books:

1. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, Mc Graw Hill, 3rd edition, 1974.
2. A.M. Goon, M.K. Gupta and B. Dasgupta, Fundamentals of Statistics Vol-I, World Press, Calcutta, 8th edition, 2002.

Master of Science (Mathematics) Semester-III
Session: 2024-26
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: 2024-26
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 viva-voce and project report as per examination policy of Kanya Maha Vidyalaya.

SEMESTER-IV

Master of Science (Mathematics)
Semester-IV
Session: 2024-26

Course Title: Graph Theory

Course Code: MMSL-4331
Course Outcomes

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

CO1: Achieve command of the fundamental definitions and concepts of graph theory.

CO2: Develop a graph theoretical model for real life situations.

CO3: Understand the structures, applications, and algorithms related to tree data structures.

CO4: Evaluate or synthesize any real world applications using graph theory based on directed or unidirected graphs in networks.

Master of Science (Mathematics)
Semester-IV
Session: 2024-26

Course Title: Graph Theory

Course Code: MMSL-4331

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 0 0	Theory: 70
	CA: 30

Instructions for Paper Setters:

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

Graph and its terminology: vertex, edge, types of vertex and edges, incidence matrix and diagram of a graph, order and size of graph, null graph, isomorphic graph, homeomorphic graph, finite and infinite graph, subgraphs and its types, Complement of a graph, Dual graphs, complete graph, regular graph, bipartite, weighted graph, planar graph

Unit II

Walk, path and its length, Cycle and its length, connected and disconnected graph, Shortest path in weighted graph, Eulerian paths and circuits, Hamiltonian paths and circuits

Unit III

Tree, distance and centers in a tree, rooted tree, binary tree, spanning tree, minimum spanning tree in a weighted graph, Kruskal's algorithm, Prim's algorithm

Unit IV

Graph coloring, vertex coloring, chromatic polynomial, chromatic number, algebraic operations in graph, Directed graph, out degree and in degree of a vertex, matrix and diagrammatic representation of directed graph

Text Book:

Gupta, S.B. and Gandhi, C.P. , Discrete Structures, 4th edition, University Science Press, New Delhi. India.

Master of Science (Mathematics)
Semester-IV
Session: 2024-26

Course Title: Topology

Course Code: MMSL-4332
Course Outcomes

Upon successful completion of this course the student 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: 2024-26

Course Title: Topology

Course Code: MMSL-4332

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 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: T_0, T_1, T_2–spaces. Regular spaces, T_3–spaces, Normal spaces, T_4–space. Tychonoff lemma, Urysohn lemma, Tietze extension theorem.

Text Book:

Munkres, J.R.,Topology, Scope as in (Ch1-6), Prentice Hall India Learning, 2002.

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: 2024-26

Course Title: Operational Research-II

Course Code: MMSL-4333
Course Outcomes

After the completion of the course, the student will be able to:

CO 1: Identify where waiting line problems occur and realize why it is important to study such problems. Understand how Poisson distribution is used to describe arrivals and exponential distribution to describe service times. Study operating characteristics of a queuing model: Single Service Channel with Poisson arrivals, exponential service times and finite or infinite calling population.

CO 2: Study operating characteristics of a queuing model: Multi Service Channel with Poisson arrivals, exponential service times and finite or infinite calling population. Learn where inventory costs occur and why it is important to hold Inventory. Learn Economic order quantity model and extend its basic approach to inventory systems involving production lot size, planned shortages and quantity discounts.

CO 3: Decide optimal replacement policy of an item that deteriorates gradually and of an item that fails suddenly. Apply various techniques to find optimum replacement age of an item so that cost is minimized.

CO 4: Understand what simulation is and how it is helpful in the analysis of a problem. Discuss simulation of inventory models, queuing system, maintenance problems and job sequencing.

Master of Science (Mathematics)
Semester-IV
Session: 2024-26

Course Title: Operational Research-II

Course Code: MMSL-4333

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 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. The students can use only Non-Programmable &Non-Storage Type Calculator.

Unit I

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

Unit II

(M/M/C):(∞/FIFO), (M/M/C):(N/FIFO), (M/M/R):(K/GD), 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 shortages 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, Queuing systems, Maintenance problem, Job sequencing.

Text Book:

K. Swarup, P.K. Gupta and M. Mohan, Operations Research, Sultan Chand & Sons, New Delhi, 19th edition, 2017. (Scope as in chapters 18, 19, 21, 22)

Reference Books:

1. N.S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., New Delhi, 2005.
2. G. Hadley, Linear Programming, Addison-Wesley Publishing Company, 1962.
3. H.A. Taha, Operations Research, Pearson Education Limited, England, 10th edition, 2017.
4. R. Panneerselvam, Operations Research, PHI Learning Private Limited, New Delhi, 2nd edition, 2009

Master of Science (Mathematics)
Semester-IV
Session: 2024-26

Course Title: Statistics-II

Course Code: MMSL-4334
Course Outcomes

After the completion of the course, the student will be able to:

CO 1: Understand the concept of sampling distribution of statistics and in particular describe the behaviour of sample mean, sample variance and order statistics and to distinguish between population and sample and between parameter and statistic.

CO 2: Describe the property of unbiasedness, consistency, sufficiency, efficiency, uniqueness and completeness and to recognize M.P. test, UMP test and BLUE.

CO 3: Identify the Applications of Chi-square, t and F Distributions in terms of different tests and Compute or approximate the probable value of test statistic and explain two types of errors.

CO 4: Demonstrate the techniques of one way and two ways ANOVA.

Master of Science (Mathematics)
Semester-IV
Session: 2024-26

Course Title: Statistics-II

Course Code: MMSL-4334

Examination Time: 3 Hrs

LTP	Max. Marks: 100
6 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. The students can use only Non Programmable& Non Storage Type Calculator and statistical tables.

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, uniqueness and completeness, methods of estimation, Testing of Hypothesis: Null hypothesis and its test of significance, simple and composite hypothesis, M.P. test, UMP test, BLUE

Unit III

Likelihood ratio test (without properties), 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.

Text Book:

S.C. Gupta and V.K Kapoor, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand and Sons, 2019

Reference Book

A.M. Goon, M.K. Gupta and B. Dasgupta, Fundamentals of Statistics, Vol-I, 8th edition, World Press, Calcutta, 2002.

Master of Science (Mathematics)
Semester-IV
Session: 2024-26

Course Title: Integral Transforms and Integral Equations
Course Code: MMSL-4335

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-IV
Session: 2024-26

Course Title: Integral Transforms and Integral Equations

Course Code: MMSL-4335

Examination Time: 3 Hours — Max. Marks: 100
Theory: 70
CA: 30

L T P
6 0 0

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