FACULTY OF SCIENCES

SYLLABUS
of

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

(Under Credit Based Continuous Evaluation Grading System)

Session: 2024-26

The Heritage Institution

KANYA MAHA VIDYALAYA
JALANDHAR
(Autonomous)

Master of Science (Mathematics)

Session: 2024-26

Programme Outcomes

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

PO 1: Solve complex Mathematical problems by critical understanding, analysis and synthesis. Students will also be able to provide a systematic understanding of the concepts and theories of Mathematics and their applications in the real world to enhance career prospects in a huge array of field.

PO 2: Have knowledge of advanced models and methods of mathematics, including same from the research frontiers of the field and expert knowledge of a well-defined field of study, based on the international level of research in Maths.

PO 3: To generate skills in independently comprehending, analysing, modelling and solving problems at a high level of abstracts based on logical & structured reasoning.

PO 4: Use computer calculations as a tool to carry out scientific investigation and develop new variants.

PO 5: Use mathematical and statistical techniques to solve well defined problems and present their mathematical work, both in oral and written format.

PO 6: Propose new mathematical linear programming techniques & suggest possible software packages or computer programming to find solution to their questions.

PO 7: Apply the knowledge in modern industry or teaching or secure acceptance in high quality graduate program in maths and other fields such as the field of quantitative/mathematical finance, mathematical computing, statistics and actuarial sciences.

PO 8: Read, understand construct correct mathematical and use the library and electronic data basis to locate information on mathematical problem.

Master of Science (Mathematics)

Session -2024-26

Program Specific outcomes

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

PSO 1: Develop a deeper and more rigorous understanding of calculus including defining terms and proving theorems about sets, functions, sequences, series, limits, continuity, derivatives, the Riemann integrals, and sequence of functions. The course will develop specialized techniques in problem solving.

PSO 2: Handle mathematical operations, analysis and problems involving complex numbers. Justify the need for a complex number system and explain how it is related to other existing number systems.

PSO 3: Understand the importance of algebraic properties with regard to working within various number systems, demonstrate ability to form and evaluate conjectures.

PSO 4: Apply differential equations to significant applied and/or theoretical problems, to model physical and biological phenomenon by differential equations and dynamical systems.

PSO 5: To describe fundamental properties including convergence, measure, differentiation and integration of the real numbers developing the theory underpinning real analysis, to appreciate how ideas and abstract methods in mathematical analysis can be applied to important practical problems.

PSO 6: To use tensor to describe measured quantities, to formulate and solve physics problems in areas such as stress, elasticity including problems in geometry, to analyze shapes in computer version and other areas of mathematical sciences.

PSO 7: To demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from field extension and Galois theory, to apply problem solving to diverse situations in physics, engineering and other mathematical contexts.

PSO 8: To understand forces linear and circular and their effects on motion, to analyze how a physical system might develop or alter over time and to study the cause of these changes.

PSO 9: To understand the concept of Relation and Function, Generation Function and Recurrence, Truth tables and its various uses in mathematics, Quantifiers, Semi Groups and Monoids, Congruence Relations

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)

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	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-1332	Complex Analysis	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-1333	Algebra-I	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-1334	Mechanics-I	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-1335	Differential Equations	C	6-0-0	6-0-0	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	80	-	20	3
TOTAL					30					

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 2024-2026)

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	Measure Theory	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-2332	Linear Algebra	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-2333	Algebra-II	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-2334	Mechanics-II	C	6-0-0	6-0-0	6	100	70	-	30	3
MMSL-2335	Number Theory	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: 2024-26
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: 2024-26
Course Title: Real Analysis
Course Code: MMSL-1331

Examination Time: 3 Hrs

LTP
6 0 0

Max. Marks: 100
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:

1. Rudin, W., Principles of Mathematical Analysis (3rdEdition), 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: 2024-26
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: 2024-26
Course Title: Complex Analysis
Course Code: MMSL-1332

Examination Time: 3 Hrs

LTP
6 0 0

Max. Marks: 100
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: 2024-26
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: 2024-26
Course Title: Algebra-I
Course Code: MMSL-1333

Examination Time: 3 Hrs

LTP
6 0 0

Max. Marks: 100
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: 2024-26
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: 2024-26
Course Title: Mechanics-I
Course Code: MMSL-1334

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 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: 2024-26
Course Title: Differential Equations
Course Code: MMSL-1335
Course Outcomes

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

CO 1: Formulate ordinary Differential Equation and also able to classify it as linear and non-linear. They will be able to find solution of a Total differential equations. Simultaneous differential equations, orthogonal trajectories and Sturm Liouville's boundary value problems.

CO 2: Understand the concept of Laplace Transformation with their properties and able to find solution of linear differential equations and simultaneous linear differential equations with constant coefficients with the help of Laplace Transformation.

CO 3: Demonstrate the concept of Fourier Transform: Definition, existence, and basic properties and its application to solve differential equations.

CO 4: Understand the concept of Special functions like Bessel functions, Hermite and Laguerre polynomials, Generating function, recurrence relations and orthogonality of Legendre polynomial

Master of Science (Mathematics)
Semester-I
Session: 2024-26
Course Title: Differential Equations
Course Code: MMSL-1335

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 question paper must contain 30% of the article/theory from the syllabus.

Unit-I

Existence and uniqueness theorem for IVP in ODEs, The method of successive approximation, general properties of solution of linear differential equation of order n, adjoint and self-adjoint equations, Total differential equations. Simultaneous differential equations, orthogonal trajectories, Sturm Liouville's boundary value problems. Sturm comparison and Separation theorems, Orthogonality solution.

Unit-II

Laplace Transform: Definition, existence, and basic properties of the Laplace transform, Inverse Laplace transform, Convolution theorem, Laplace transform solution of linear differential equations and simultaneous linear differential equations with constant coefficients.

Unit-III

Fourier Transform: Definition, existence, and basic properties, Convolution theorem, Fourier transform of derivatives and Integrals, Inverse Fourier transform, solution of linear ordinary differential equations, Complex Inversion formula.

Unit-IV

Special Functions: Solution, Generating function, recurrence relations and othogonality of Legendre polynomial, Bessel functions, Hermite and Laguerre polynomials.

Reference Books:

1. Rainvile, E.D., Special Functions, Chelsea Publications Co., 1971.
2. Piaggio, H.T.H., Differential equations, C.B.S.Publications,2004.
3. Ross, S.L.: Differential equations, Wiley Publications,2007.
4. Pinkus, A. and Zafrany, S., Fourier series and Integral Transforms, Cambridge University Press, 1997.

Master of Science (Mathematics)
Semester-II
Session 2024-26
Course Title: Measure Theory
Course Code: MMSL-2331

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

CO 1: Understand the fundamentals concepts of measure theory which include the topics of outer measure, σ-algebra of Lebesgue measurable sets, Borel σ-algebra of subsets of real line, measurable sets, non-measurable sets,.

CO 2: Manage to understand Measurable function, characteristic function and Little wood's three principles.

CO 3: apply Lebesgue Integral on different kind of function and solve problems related to Fatou's Lemma and monotone convergence theorem.

CO 4: To understand general Lebesgue integral with Lebesgue dominated convergence theorem and to define The Vitali convergence Theorem and to apply Characterizations of Riemann and Lebesgue integrability.

Master of Science (Mathematics)
Semester-II
Session 2024-26
Course Title: Measure Theory
Course Code: MMSL-2331

Examination Time: 3 Hrs

LT P | 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

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 motivationbehindLebesgueMeasurableFunctions,variousCharacterizationsandProperties 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 Riemannand 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.

Reference Books:

1.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.

Master of Science (Mathematics)
Semester-II
Session 2024-26
Course Title: Linear Algebra
Course Code: MMSL-2332
Course Outcomes

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

CO1:To understand the concept of vector space, Quotient Spaces, Basis and Dimension and Linear transformations.

CO2: To understand matrix representation of a linear transformation, Elementary matrix operations and rank of a matrix.

CO3: To find eigen values and eigenvectors of a matrix, Diagonalization, Linear Functionals, Dual Spaces and dual basis.

CO4: To identify Inner Product Spaces, The Gram-Schmidt Orthogonalization, Orthogonal Complements, Normal and Self-Adjoint Operators, Unitary and Normal Operators.

Master of Science (Mathematics)
Semester-II
Session 2024-26
Course Title: Linear Algebra
Course Code: MMSL-2332

Examination Time: 3 Hrs

LT P	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

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

Reference Books:

1. Hoffman, K.andKunze, R., Linear Algebra, Second Edition, Prentice Hall India Learning, 2015.
2. Friedberg, S.H., Insel, A.J, Spence, L.E., Linear Algebra, Fourth Edition, Prentice Hall, 2003.
3. Lang, S., Linear Algebra, Third Edition, Springer-Verlag,1987.

Master of Science (Mathematics)
Semester-II
Session: 2024-26
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: 2024-26
Course Title: Algebra-II
Course Code: MMSL-2333

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

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: 2024-26
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: 2024-26
Course Title: Mechanics -II
Course Code: MMSL-2334

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 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 2024-26
Course Title: Number Theory
Course Code: MMSL-2335
Course Outcomes

Successful completion of this course will enable the students to:

CO 1: Solve system of given linear and non linear congruences. Further the student will be able to apply the Wilson's theorem to solve numerical problems.

CO 2: Understand the properties and application of Quadratic residue and corresponding symbols.

CO 3: Find integral solutions of specified Diophantine equation and understand the criterion for an integer to be expressed as sum of two squares and sum of four squares.

CO 4: Understand the basic concept of periodic and purely periodic continued fractions and apply the Pell's equation to real life problems.

Master of Science (Mathematics)
Semester-II
Session 2024-26
Course Title: Number Theory
Course Code: MMSL-2335

Examination Time: 3 Hrs

LT P	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

Simultaneous Linear Congruences, Chinese Remainder theorem, 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 $\mathcal{C}(n)$, $\sigma(n)$, $\sigma_k(n)$, $\mu(n)$, Perfect numbers, Mobius Inversion formula, Diophantine equation $x^2+ y^2= z^2$and its applications to $x^n+ y^n= z^n$, 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.

ReferenceBooks:

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.
3. Burton, D.M., Elementary Number Theory, Mc Graw Hill Education, 2017.

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 2024-2025)

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-I	C	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-3332	Topology-I	C	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-3333 (OPT-I)	Discrete Mathematics-I	E	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-3334 (OPT-III)	Statistics-I	E	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-3335 (OPT-IV)	Operations Research-I	E	4-1-0	4-1-0	5	100	80	-	20	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	80	-	20	3
TOTAL					25	500				

IDEC-3101	Communication Skills
IDEM-3362	Basics of Music (Vocal)
IDEH-3313	Human Rights and Constitutional Duties
IDEI-3124	Basics of Computer Applications
IDEW-3275	Indian Heritage: Contribution to the World
	(Credits of these courses will not be added to SGPA)

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

Note 1:

In addition to two compulsory papers in third and fourth semester, student has to choose three optional papers in each third and fourth semester keeping in view the prerequisites and suitability of the combinations.

OPT-I Discrete Mathematics-I
OPT-II Integral Transforms
OPT-III Statistics-I
OPT-IV Operations Research-I
OPT-V Advanced Numerical Analysis
OPT-VI Discrete Mathematics-II
OPT-VII Number Theory
OPT-VIII Statistics-II
OPT-IX Operations Research-II
OPT-X Computer Programming with C

Master of Science (Mathematics)
Semester-III
Session: 2024-25
Course Title: Functional Analysis-I
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 3: 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: 2024-25
Course Title: Functional Analysis-I
Course Code: MMSL-3331

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 80
	CA: 20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 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 Book:

P. K. Jain, O.P Ahuja, Functional Analysis, New Age International (P) Ltd. Publishers, New Delhi, Second Edition, 2017

Reference Book:

D. Somasundram, A First Course in Functional Analysis, Narosa Publishing House Pvt. Ltd ,New Delhi, Seventh Edition, 2018.

Master of Science (Mathematics)
Semester-III
Session: 2024-25
Course Title: Topology-I
Course Code: MMSL-3332
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: Know and understand the concepts related to separation axioms such as $T_{0,}$ T_1

andT_2 spaces.

CO 4: Create new topological spaces by using product topologies and quotient topologies.

Master of Science (Mathematics)
Semester-III
Session: 2024-25
Course Title: Topology-I
Course Code: MMSL-3332

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 80
	CA: 20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 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, Neighbourhood's and Neighbourhood system .Coarser and finer topologies. 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 point. Invariants under a continuous mapping. Open and closed mappings. Homeomorphism and embedding. Topological properties.

UNIT-III

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

UNIT-IV

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. Quotient spaces.

Text Book:

J. R. Munkers, Topology, Pearson Education Publisher, England, Second Edition, 2021.

Reference Books:

1. T.O. Moore, Elementary General Topology, Prentice Hall Publisher, New Jersey, 1965.
2. J. L. Kelley, General Topology, Springer, New York.
3.G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education, 2017.

Master of Science (Mathematics)
Semester-III
Session: 2024-25
Course Title: Discrete Mathematics-I
Course Code: MMSL-3333(OPT-I)
Course Outcomes

Having successfully completed this course the students will be able to:

CO 1: Work with Relations and functions and investigate their Properties.

CO 2: Use the Truth Tables for the Expressions involving the Logical Connectives, and Apply the Standard Logical Equivalences and Determine if a Logical Arguments is valid or invalid.

CO 3: Understand the concept of Semi groups and Monoids

CO 4: Learn Recursive Functions and Solve Recurrence Relations and Apply Basic and Advanced Principles of Counting.

Master of Science (Mathematics)
Semester-III
Session: 2024-25
Course Title: Discrete Mathematics-I
Course Code: MMSL-3333(OPT-I)

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 80
	CA: 20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 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

Relations and Functions: Binary elations ,Equivalence relations and partitions, Partial order relations, Inclusion and Exclusion principle, Hasse diagram ,Pigeonhole principle.

UNIT-II

Mathematical Logic : Basic logical operations, Conditional and Biconditional statements, Tautologies, Contradiction, Quantifiers, Prepositional calculus.

UNIT-III

Semi Group sand Monoids: Definition and examples of semi groups and monoids ,Homomorphism of semi groups and monoids, Congruence relations and quotient subgroups.

UNIT-IV

Recurrence Relations and Generating Functions: Polynomial expressions, Telescopic form, recursion theorem, Closed form expression, Generating function, Solution of recurrence relation using generating function.

Text Books :

A. Doer, Applied Discrete Structures For Computer Science, Galgotia Publications Pvt. Ltd., New Delhi, Reprint 1999

Reference Books ;

1.C. L Liu, Elements of Discrete Mathematics, McGraw Hill Education Revised Fourth Edition, 1 July 2017
2.V. H Patil, Discrete Mathematics, McGraw Hill Education Revised Third Edition, 1 July 2017
3.Babu Ram, Discrete Mathematics, Pearson Education India, First Edition (1 January, 2010)

Master of Science (Mathematics)
Semester-III
Session: 2024-25
Course Title: Statistics-I
Course Code: MMSL-3334(OPT-III)

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: 2024-25
Course Title: Statistics-I
Course Code: MMSL-3334(OPT-III)

Examination Time: 3 Hrs

LTP
4 1 0

Max. Marks: 100
Theory: 80
CA: 20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 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: 2024-25
Course Title: Operations Research-I
Course Code: MMSL-3335 (OPT-IV)
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: 2024-25
Course Title: Operations Research-I
Course Code: MMSL-3335 (OPT-IV)

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 80
	CA: 20

Instructions for the paper setters/examiners:
Eight questions of equal marks (16 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.

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 2024-2025)

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-II	C	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-4332	Topology-II	C	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-4333 (OPT-VII)	Number Theory	E	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-4334 (OPT-VIII)	Statistics-II	E	4-1-0	4-1-0	5	100	80	-	20	3
MMSL-4335 (OPT-IX)	Operations Research-II	E	4-1-0	4-1-0	5	100	80	-	20	3
MMSD-4336	Project	C	0-0-10	0-0-5	5	100	-	80	20	3
TOTAL					30	600				

Note:

In addition to two compulsory papers in third and fourth semester, student has to choose three optional papers in each third and fourth semester keeping in view the prerequisites and suitability of the combinations.

OPT-I Discrete Mathematics-I
OPT-II Integral Transforms
OPT-III Statistics-I
OPT-IV Operations Research-I
OPT-V Advanced Numerical Analysis

OPT-VI Discrete Mathematics-II
OPT-VII Number Theory
OPT-VIII Statistics-II
OPT-IX Operations Research-II
OPT-X Computer Programming with C

C-Compulsory

E-Elective

Master of Science (Mathematics) Semester-IV
Session 2024-25
Course Title: Functional Analysis-II
Course Code: MMSL-4331
Course Outcomes

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

CO 1: Understand the concept of strong and weak convergence in finite and infinite dimensional normed linear spaces and to describe the different operator like, adjoint of an operator, self-adjoint operator, and unitary operator.

CO 2: Demonstrate how to find the Eigen values and Eigen vectors for finite dimensional spaces and State and Prove Spectral Theorem for normal operators.

CO 3: Understand the concept of Compact Linear Operators on Normed space.

CO 4: To know the topological division of zeros and formulate for spectral radius and to classify the regular and singular elements.

Master of Science (Mathematics)
Semester-IV
Session 2024-25
Course Title: Functional Analysis-II
Course Code: MMSL-4331

Examination Time: 3 Hrs
LTP
4 1 0

Max. Marks: 100
Theory: 80
CA: 20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 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

Strong and weak convergence in finite and infinite dimensional normed linear spaces. Weak convergences in Hilbert spaces, Weakly compact sets in Hilbert spaces, The adjoint of an operator, Self adjoint operators, Normal operators, Unitary operators.

UNIT-II

Finite dimensional spectral Theory.: Eigen- values and Eigen vectors, Spectrum of a bounded linear operator, Spectrum of Self-adjoint, Positive and Unitary operators. Spectral Theorem for normal operators.

UNIT-III

Compact Linear Operator on Normed spaces, Properties of compact linear operators, Spectral properties of compact linear operators.

UNIT-IV

Banach algebras: Definitions and simple examples. Regular and singular elements. Topological divisors of zero, Spectrum of an element of Banach Algebra, Formula for spectral radius.

Text Book:

D. Somasundram , A First Course in Functional Analysis, Narosa Publishing House Pvt. Ltd, Seventh Reprint 2018.

Reference Books :

1.E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons, Singapore, 2019

2.P. K Jain, O. P Ahuja, Functional Analysis, New Age International (P) Limited Publishers, Daryaganj, New Delhi, Third Edition, 2020

Master of Science (Mathematics)
Semester-IV
Session 2024-25
Course Title: Topology-II
Course Code: MMSL-4332
Course Outcomes

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

CO 1: Know and understand the concepts related to higher separation axioms such as Completely regular spaces, T5 – spaces and Tychonoff spaces etc.

CO 2: Understand and interpret the knowledge regarding Compact spaces, Relation of compact spaces with Hausdorff spaces, Countably compact spaces and One point compactification.

CO 3: Demonstrate knowledge and understanding of Metric spaces & Metrizability of topological spaces.

CO 4: Understand terms, definitions & theorems related to Net, Filter, Ultra filter and convergence of net and filters.

Master of Science (Mathematics)
Semester-IV
Session 2024-25
Course Title: Topology-II
Course Code: MMSL-4332

Examination Time: 3 Hrs

LTP
4 1 0

Max. Marks: 100
Theory: 80
CA: 20

Instructions for the paper setters/examiners

Eight questions of equal marks (16 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

Higher Separation Axioms: Completely regular spaces. Tychonoff spaces, completely normal space, T5 – spaces. Metric spaces as Hausdorff regular, normal and completely normal space. Product of metric spaces.

UNIT-II

Compact spaces, Compact sets, Subsets of compact space. Finite intersection property. Compactness of subsets of real line. Relation of compact spaces with Hausdorff spaces, Regular spaces and normal spaces. Sequentially compact spaces, Bolzano Weierstrass property. Countably compact spaces. Locally compact spaces. Compactness in terms of base elements and sub – base elements. Tychonoff theorem. One point compactification.

UNIT-III

The Stone-Čechcompactification, Evaluation mappings, Separate point family, Separate point and closed set family. Embedding lemma, Tychonoff cube, Embedding theorem, Metrization. Urysohnmetrization theorem

UNIT-IV

Directed sets and nets. Convergence of a net in a space, Clustering of a net, nets and continuity, Nets in product spaces, Ultra nets. Compactness in term of nets, Topologies determined by nets. Filters and their convergence. Canonical way of converting nets to filters and vice-versa. Ultra-filters and compactness.

Text Book:

J.R.Munkers, Topology, Pearson Education Publisher, England, Second Edition, 2021.

Reference Books:

1. T.O. Moore, Elementary General Topology, Prentice Hall Publisher, New Jersey, 1965.

2. J.L. Kelley, General Topology, Springer, New York.

3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education, 2017.

Master of Science Mathematics Semester-IV

Session 2024-25

Course Title: Number Theory

Course Code: MMSL-4333(OPT-VII)

Course Outcomes

Successful completion of this course will enable the students to:

CO 1: Prove results involving divisibility and greatest common divisors and solve system of given linear and non linear congruences. Further the student will be able to apply the Wilson's and Euler- Fermat's theorem to solve numerical problems.

CO 2: Understand the properties and application of Quadratic residue and corresponding symbols.

CO 3: Find integral solutions of specified Diophantine equation and understand the criterion for an integer to be expressed as sum of two squares and sum of four squares.

CO 4: Understand the basic concept of periodic and purely periodic continued fractions and apply the Pell's equation to real life problems.

Master of Science (Mathematics)
Semester-IV
Session 2024-25
Course Title: Number Theory
Course Code: MMSL-4333(OPT-VII)

Examination Time: 3 Hrs

LTP
4 1 0

Max. Marks: 100
Theory: 80
CA: 20

Instructions for the paper setters/examiners

Eight questions of equal marks (16 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 Congruences, Chinese Remainder theorem with applications, Wolsten-Holme's theorem, Lagrange's proof of Wilson theorem, Fermat numbers, 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, Legendre symbol and its properties, Gauss's Lemma, Quadratic reciprocity law, Jacobian symbol and its properties..

UNIT-III

Arithmetic functions τ (n), σ (n), σ_k (n), μ (n), Perfect numbers, Mobius inversion formula, Diophantine equation $x^2 + y^2 = z^2$and its applications to $x^n + y^n = z^n$ 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, Fundamental solution of Pell's equation.

Text Books

1. D. M. Burton, Elementary Number Theory, McGraw Hill, 7th edition, 2010 (Scope as in Chapters: 4, 6-8, 11-13, 15).

2. G.H. Hardy and E.M. Wright, Theory of Numbers, Oxford University Press, 6th edition, 2008 (Scope as in Chapter: 7).

Reference Book:

Niven and H.S. Zuckerman, An Introduction to the Theory of Numbers, Wiley Publication, 5th edition, 2008.

Master of Science (Mathematics)
Semester-IV
Session 2024-25
Course Title: Statistics-II
Course Code: MMSL-4334(OPT-VIII)

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 2024-25
Course Title: Statistics-II
Course Code: MMSL-4334(OPT-VIII)

Examination Time: 3 Hrs

LT P	Max. Marks: 100
4 1 0	Theory: 80
	CA: 20

Instructions for the paper setters/examiners:

Eight questions of equal marks (12 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 2024-25
Course Title: Operations Research-II
Course Code: MMSL-4335 (OPT-IX)
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 2024-25
Course Title: Operations Research-II
Course Code: MMSL-4335 (OPT-IX)

Examination Time: 3 Hrs

LTP	Max. Marks: 100
4 1 0	Theory: 80
	CA: 20

Instructions for the paper setters/examiners:

Eight questions of equal marks (16 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 2024-25
Course Title: Project
Course Code: MMSD-4336
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-IV
Session 2024-25
Course Title: Project
Course Code: MMSD-4336

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 perexamination policy of Kanya Maha Vidyalaya.