Month-wise Schedule of M.Sc. (MATHEMATICS) Part I

SESSION 2022-23(SEMESTER-1)

Faculty Title of Paper	October	November	December
Dr. DB Rishi MATM1101T Algebra-I	Review of groups, Normal and subnormal series, Solvable groups, Nilpotent groups, Composition Series, Jordan-Holder theorem for groups. Group action, Stabilizer, orbit.	Class equation and its applications permutation groups, cyclic decomposition,, conjugacy classes in permutation groups. Alternating group A_n, Simplicity of A_n. Structure theory of groups, Fundamental theorem of finitely generated abelian groups, Invariants of a finite abelian group.	Groups of Automorphisms of cyclic groups, homomorphism between two cyclic groups, Sylow's theorems, Groups of order p2, pq. Review of rings and homomorphism of rings, Ideals, Algebra of Ideals, Maximal and prime ideals, Ideal in Quotient rings, Field of Quotients of integral Domain, Matrix Rings and their ideals; Rings of Endomorphisms of Abelian Groups.
Mr. Inderjeet Singh MATM1102T Mathematical Analysis	Functional of several variables: Linear transformations, Derivatives in an open subset of Rn , Chain Rule, Partial derivatives, Interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem Inverse function theorem, Implicit function theorem. Algebras, σ-algebra, their properties,,	General measurable spaces, measure spaces, properties of measure, Complete measure, Lebesgue outer measure and its properties, measurable sets and Lebesque measure, A non measurable set. Measurable function w.r.t. general measure. Borel and Lebesgue measurability. Integration of non-negative measurable functions, Fatou's lemma, Monotone convergence theorem, Lebesgue convergence theorem, The general integral, Integration of series, Riemann and lebesgue integrals	Differentiation; Vitalis Lemma, The Dini derivatives, Functions of bounded variation, Differentiation of an Integral, Absolute Continuity, Convex Fucntions and Jensen's inequality.

Dr. DB Rishi **MATM1103T** **Topology-I**	Cardinals: Equipotent sets, Countable and Uncountable sets, Cardinal Numbers and their Arithmetic, Bernstein's Theorem and the Continumm Hypothesis. Topological Spaces: Definition and examples, Euclidean spaces as topological spaces, Basis for a given topology, Topologizing of Sets; Sub-bas Elementary Concepts: Closure, Interior, Frontier and Dense Sets, Topologizing with pre-assigned elementary operations. Relativization, Subspaces is, Equivalent Basis.	Maps and Product Spaces: Continuous Maps, Restriction of Domain and Range, Characterization of Continuity, Continuity at a point, Piecewise definition of Maps and Neighborhood finite families. Open Maps and Closed Maps, Homeomorphisms and Embeddings. Cartesian Product Topology, Elementary Concepts in Product Spaces, Continuity of Maps in Product Spaces and Slices in Cartesian Products. Connectedness: Connectedness and its characterizations, Continuous image of connected sets, Connectedness of Product Spaces, Applications to Euclidean spaces. Components, Local Connectedness and Components, Product of Locally Connected Spaces. Path Connectedness.	. Compactness and Countability: Compactness and Countable Compactness, Local Compactness, One-point Compactification, T¬0, T1, and T2 spaces, T2 spaces and Sequences and Hausdorfness of One-Point Compactification. Axioms of Countablity and Separability, Equivalence of Second axiom, Separable and Lindelof in Metric Spaces. Equivalence of Compact and Countably Compact Sets in Metric Spaces

Dr. Amrit Pal Singh MATM1104T Differential Geometry	Theory of Space Curves: Curves in the planes and in space, arc length, reparametrization, curvature, Serret-Frenet formulae. osculating circles, evolutes and involutes of curves, space curves, torsion, Serret-Frenet formulae. Theory of Surfaces, smooth surfaces, tangents, normals and orientability, quadric surfaces, the first and the second fundamental forms, Euler's theorem. Rodrigue's formula.	Gaussian Curvature, Gauss map and Geodesics: The Gaussian and mean curvatures, the pseudosphere, flat surfaces, surfaces of constant mean curvature. Gaussian curvature of compact surfaces, the Gauss map, Geodesics, geodesic equations, geodesics of surfaces of revolution, geodesics as shortest paths, geodesic	coordinates.Minimal Surfaces and Gauss's Remarkable Theorem: Plateau's problem, examples of minimal surfaces, Gauss map of a minimal surface, minimal surfaces and holomorphic functions, Gauss's Remarkable Theorem, isometries of surfaces, The Codazzi-Mainardi Equations, compact surface of constant Gaussian curvature
Prof Harjinder Singh MATM1107T Linear Programming	Linear programming problems (LPPs); Examples, Mathematical formulation, Graphical solution, Solution by Simplex method, artificial variables,Big-M method and two phase simplex method.: Duality in linear programming; Concept, Mathematical formulation, fundamental properties of duality, duality and simplex method and dual simplex method	. Sensitivity Analysis Discrete changes in the cost vector, requirement vector and Co-efficient matrix, Transportation problem ; initial basic feasible solution and Optimal solutions using MODI method (for balanced cases only), Assignment problem; solution of balanced and unbalanced	assignment problems, maximization case in as Sequencing Problems; General Assumptions, Processing n jobs through m machines. Replacement decisions; O.R methodology of solving replacement problems, Replacement of items that deteriorates with time without and with change in the money value.signment problem.

Month-wise Schedule of M.Sc. (MATHEMATICS) Part I

SESSION 2022-23(SEMESTER-2)

Faculty Title of Paper	February	March	April	May
Mr. Prakash Chandra Joshi **MATM1201T** **Algebra-II**	Unique Factorization Domains, Principal Ideal Domains, Euclidean Domains, Polynomial Rings over UFD, Rings of Fractions.	Modules: Definition and Examples, Submodules, Direct sum of submodules, Free modules, Difference between modules and vector spaces, Quotient modules, Homomorphism, Simple modules, Modules over PID.	Modules with chain conditions: Artinian Modules, Noetherian Modules, Artinian Implies Noetherian in Rings, Composition series of a module, Length of a module, Hilbert Basis Theorem..	Cohen Theorem, Radical Ideal, Nil Radical, Jacobson Radical, Radical of an Artinian ring. Nil Radical and Jacobson Radical of Polynomial Rings R[x], R commutative.
Dr. DB Rishi **MATM1202T** **Topology-II**	Higher Separation Axioms: Regular, Completely Regular, Normal and Completely Normal Spaces. Metric Spaces as Completely Normal T2 Spaces. Urysohns Lemma and The Tietze Extension Theorem. Products : Products of first countable, Regular, T2 and Completely Regular Spaces.	Non invariance of normality under products. Embedding of Tichonov spaces into parallelotope and the Stone Cech Compactification. Filters : Filter and filter base, convergence and clustering, filter characterization of closure, continuity and filter convergence, ultrafilters, filter characterization of compactness and the Tychonoff Theorem.	Identification Topology: Identification Topology, Identification Map, Subspaces, General Theorem, Transgression, Transitivity Spaces with Equivalance Relation, Quotient Spaces. Categories and Functors: Categories: Definition and Examples, The Arrow Category, Congruence in a Category, Quotient Category, Functors, Duality, Contravariance and Duality,	Homotopy as Congruence in Top, The Category hTop, homotopy equivalence, nullhomotopy, convexity, contractibility and cones, the path component functor, invariance of path components under homotopy type.

Dr. Amrit Pal Singh MATM1207T **Classical Mechanics**	Basic Principles: Mechanics of a Particle and a System of Particles, Constraints , Generalized Coordinates, Holonomic and Non-Holonomic Constraints. D'Alemberts Principle and Lagrange's Equations, Velocity Dependent Potentials and the Dissipation Function, Simple Applications of the Lagrangian formulation. Variational Principles and Lagrange's Equations: Hamilton's Principle, Derivation of Lagrange's Equations from Hamilton's Principle, Extension of Hamilton's Principle to Non-Holonomic Systems.	Conservation Theorems and Symmetry Properties: Cyclic Coordinates, Canonical Momentum and its Conservation, The Generalized Force, and Angular Momentum Conservation Theorem. The Two-Body Central Force Problem: Reduction to the Equivalent One-Body Problem, The Equation of Motion, The Equivalent One Dimensional Problem and the Classification of Orbits, The Virial Theorem, Conditions for Closed Orbits, Bertrand's Theorem.	The Kepler Problem: Inverse Square Law of Force, The Motion in Time in the Kepler Problem, Kepler's Laws, Kepler's Equation, The Laplace-Runge-Lenz Vector. Scattering in a Central Force Field: Cross Section of Scattering, Rutherford Scattering Cross Section, Total Scattering Cross Section, Transformation of the Scattering Problem to Laboratory Coordinates.	The Kepler Problem: Inverse Square Law of Force, The Motion in Time in the Kepler Problem, Kepler's Laws, Kepler's Equation, The Laplace-Runge-Lenz Vector. Scattering in a Central Force Field: Cross Section of Scattering, Rutherford Scattering Cross Section, Total Scattering Cross Section, Transformation of the Scattering Problem to Laboratory Coordinates.

Mr. Inderjeet Singh **MATM1203T** **Differential Equations -I**	Existence of solution of ODE of first order, initial value problem, Ascoli's Lemma, Gronwall's inequality, Cauchy Peano Existence Theorem, Uniqueness of Solutions. Method of successive approximations, Existence and Uniqueness Theorem.	System of differential equations, nth order differential equation, Existence and Uniqueness of solutions, dependence of solutions on initial conditions and parameters. Linear system of equations (homogeneous & non homogeneous). Superposition principle, Fundamental set of solutions, Fundamental Matrix, Wronskian.	Abel Liouville formula, Reduction of order, Adjoint systems and self adjoint systems of second order, Floquet Theory. Linear 2nd order equations, preliminaries, Sturm's separation theorem, Sturm's fundamental comparison theorem,	Sturm Liouville boundary value problem, Characteristic values & Characteristic functions, Orthogonality of Characteristic functions, Expansion of a function in a series of orthonormal functions.
Prof Harjinder Singh **MATM1204T** **Complex Analysis**	Function of complex variable, Analytic function, Cauchy-Riemann equations, Harmonic function and Harmonic conjugates, Branches of multivalued functions with reference to arg z, log z .	Conformal Mapping. Complex Integration, Cauchy's theorem, Cauchy Goursat theorem Cauchy integral formula, Morera's theorem, Liouville's theorem, Fundamental theorem of Algebra, Maximum Modulus Principle. Schwarz lemma.	Taylor's theorem. Laurent series in an annulus. Singularities, Meromorphic function. Cauchy's theorem on residues. Application to evaluation of definite integrals. Principle of analytic continuation, General definition of an analytic function. Analytic continuation by power series method, Natural boundary, Harmonic functions on a disc, Schwarz Reflection principle, Mittag-Leffler's theorem .	Natural boundary, Harmonic functions on a disc, Schwarz Reflection principle, Mittag-Leffler's theorem .

Month-wise Schedule of M.Sc. (MATHEMATICS) Part II

SESSION 2022-23(SEMESTER-3)

Faculty Title of Paper	SEPTEMBER	October	November	December
Dr. Amrit pal singh **MM- 602 FIELD THEORY**	fields, examples, Algebraic and transcendental elements, Irreducible polynomials. Gauss lemma, Eisenstein's criterion, Adjunction of roots, Kronecker's theorem, algebraic extensions, algebraically closed fields.	Splitting fields, Normal extensions, multiple roots, finite fields, Separable extensions, perfect fields, primitive elements, Lagrange's theorem on primitive elements.	Automorphism groups and fixed fields, Galois extensions, Fundamental theorem of Galois theory, Fundamental theorem of algebra, Roots of unity and cyclotomic polynomials. Cyclic extension, Polynomials solvable by radicals,	Symmetric functions, cyclotomic extension, quintic equation and solvability by radicals, Ruler and Compass construction.
Mr. Inderjeet Singh **MM 603 Differential Equations –II**	Existance and uniqueness of solutions of first order differential equations for complex systems.	Maximum and minimum solution. Caratheodory theorem. Continuation of solution. Uniqueness of solutions and Successive approximations. Variation of Solutions.	Partial Differential Equations: Occurrence and elementary solution of Laplace equation. Family of equipotential surface. Interior and exterior Dirichlet boundary value problem for Laplace equation	Separation of Variables. Axial symmetry, Kelvin's inversion theorem. Green's function for Laplace equation. Dirichlet's problem for semi-infinite space and for a sphere. Copson's Theorem (Statement only)

Prof. Harjinder Singh **MM- 609** **OPTIMIZATION TECH.**	**Introduction:** Definition of operation research, models in operation research, general methods for solving O.R. models, Elementary theory of convex sets. **Linear Programming Problems:** Definition of LPP, examples of LPPs, mathematical formulation of the mathematical programming problems, Graphical solution of the problem. Simplex method, Big M method, Two Phase method, problem of degeneracy.	**Duality in linear programming:** Concept of duality, fundamental properties of duality, duality theorems, complementary slackness theorem, duality and simplex method, dual simplex method. **Sensitivity Analysis:** Discrete changes in the cost vector, requirement vector and co-efficient matrix, addition of a new variable, deletion of a variable, addition of new constraint, deletion of a constraint. **Integer Programming:** Introduction, Gomory's all-IPP method, Gomory's mixed-integer method, Branch and Bound method.	**Transportation Problem:** Introduction, mathematical formulation of the problem, initial basic feasible solution using North West Corner Method, Least Cost Method and Vogel's Approximation Method, Optimal solution using MODI method, degeneracy in transportation problems, some exceptional cases in transportation problem	**Assignment Problems:** Introduction, mathematical formulation of an assignment problem, assignment algorithm, unbalanced assignment problems, Travelling Salesman problem. **Games & Strategies**: Definition & characteristics of Games. Two person zero sum games, Maximin-minimax principle, Games without saddle points, Mixed Strategies, Graphical method for solving and games, Concept of Dominance, Reducing the game problem to LPP, Limitations.

Dr. Amrit pal singh **MM- 610 FUZZY SETS AND APPLICATIONS**	**Classical Sets and Fuzzy Sets:** Overview of Classical Sets, Membership Function, a-cuts, Properties of a-cuts, Decomposition Theorems, Extension Principle. **Operations on Fuzzy Sets:** Compliment, Intersections, Unions, Combinations of operations, Aggregation Operations.	**Fuzzy Arithmetic:** Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on intervals and Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. **Fuzzy Relations:** Crisp and Fuzzy Relations, Projections and Cylindric Extensions, Binary	Fuzzy Relations, Binary Relations on single set, Equivalence, Compatibility and Ordering Relations, Morphisms, Fuzzy Relation Equations. **Possibility Theory:** Fuzzy Measures, Evidence and Possibility Theory, Possibility versus Probability Theory.	**Fuzzy Logic:** Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges. **Uncertainty based Information:** Information and Uncertainty, Nonspecificity of Fuzzy and Crisp sets, Fuzziness of Fuzzy Sets. Applications of Fuzzy Logic.
Dr. D B Rishi **MM 612: FUNCTIONAL ANALYSIS**	Normed Linear spaces, Banach spaces, Examples of Banach spaces and subspaces. Continuity of Linear maps, Equivalent norms. Normed spaces of bounded linear maps. Bounded Linear functional. Hahn-Banach theorem in Linear Spaces and its applications.	Hahn-Banach theorem in normed linear spaces and its applications.Uniform boundedness principle, Open mapping theorem, Projections on Banach spaces, Closed graph theorem.	The conjugate of an operator. Dual spaces of lp and C [a,b], Reflexivity. Hilbert spaces, examples, Orthogonality, Orthonormal sets, Bessel's inequality, Parseval's theorem. The conjugate space of a Hilbert spaces. Adjoint operators, Self-adjoint operators, Normal and unitary operators. Projection operators	Spectrum of an operator, Spectral Theorem, Banach Fixed Point Theorem, Brower's Fixed Point Theorem. Schauder Fixed Point Theorem, Picards Theorem. Applications of Fixed point theorem in differential equations and integral equations.

Month-wise Schedule of M.Sc. (MATHEMATICS) Part II

SESSION 2022-23(SEMESTER-4)

Faculty Title of Paper	February	March	April	May
Dr. D B Rishi MM-702 THEORY OF LINEAR OPERATORS	Spectral theory in normed linear spaces, resolvant set and spectrum. Spectral properties of bounded linear operator. Properties of resolvant and spectrum. Spectral mapping theorem for polynomials, spectral radius of bounded linear operator on a complex Banach space.	Elementary theory of Banach algebras. Resolvant set and spectrum. Invertible elements, Resolvant equation. General properties of compact linear operators, Spectral properties of compact linear operators on normed space. Behaviour of compact linear operators with respect to solvability of operator equations linear operators.	Fredholm type theorems. Fredholm alternative theorems. Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space. Positive operators. Monotone sequence theorem for bounded self-adjoint operators on a complex Hilbert spaceSquare roots of positive operators. Spectral family of a bounded self-adjoint linear operator and its properties, Spectral theorem.	Square roots of positive operators. Spectral family of a bounded self-adjoint linear operator and its properties, Spectral theorem.

Prof. Harjinder Singh **MM- 705 OPTIMIZATION TECH -II**	Quadratic Programming: Wolfe's Modified Simplex Method, Beale's method for Quadratic Programming, Separable, Convex programming. Linear Complimentary Problem : Lemke's Complementary Pivoting Algorithm, Solution of Quadratic programming, Problems using Linear Complementary method.	Separable Programming: Introduction, Reduction of Separable Programming to Linear programming Problem, Separable Programming Algorithm Goal Programming: Introduction, formulation of linear Goal Programming, Graphical & Simplex Method for Goal Programming. Geometric Programming: Introduction, constrained & unconstrained Geometric Programming Problem, Complementary Geometric programming.	Fractionl Programming : Introduction, Mathematical formulation of Linear fractional programming problem, Method due to Charnes and Cooper, Problems of Fractional Programming .Dynamic Programming: Introduction, nature of Dynamic Programming (DP), Solution of DiscreteDPP, Application of DP in Linear Programming. Decision Theory: Introduction & components of Decision Theory, EMV,EOL, Decision making under uncertainty, Decision making under utilities, Decision making under Risk.	Simulation: Introduction, Advantages & disadvantages, Event – type, Monte-Carlo simulation, Application to Inventory, Queueing, Capital Budgeting, Financial Planning, Maintenance, Job Sequencing, Networks.
Dr. Amrit pal singh **MM- 708 FLUID MECHANICS**	Equations of Fluid Mechanics : Real and continuous fluids, differentiation following the motion, equation of continuity, Stream function, Stream lines, Pressure, Euler's equation of motion. Bernoulli's theorem Steady irrotational non-viscous compressible flow. Vorticity, circulation,	Kelvin's theorem on constancy of circulation, Kinetic energy. Three dimensional problems : Laplace's equation. Three dimensional sources and dipoles. Spherical obstacle in a uniform Steam . Application of complex variable method : Conjugate functions in plane, complex potential ,am Moving sphere, images.	Incompressible flow in two dimensions, uniform stream, Source and sink, Vortex, Two dimensional dipole, Superposition, Joukowski's transformation. Milne Thomson circle theorem, Blasius theorem, Drag and lift. Source and vortex filaments, vortex pair, rows of vortices, Karman cortex street. Viscous flow : Navier Stokes equations,	Dissipation of energy. Diffusion of vorticity in an incompressible fluid, condition of no slip, Steady flow between two parallel infinite flat plates, steady flow through a straight circular pipe (Poiseuille Flow).

Mr. Inderjeet Singh **MM-716** **MATHEMATICAL METHODS**	Linear integral equations of first and second kind, Abel's problem, Relation between linear differential equation and Volterra's equation, Non linear and Singular equations, Solution by successive substitutions, Volterra's equation iterated and reciprocal functions, Volterra's solution of Fredholm's equation. Fredholm's equation as limit of finite system of linear equations,	Hadamard's theorem, convergence proof, Fredholm's two fundamental relations, Fredholm's solution of integral equation when $D(\lambda)\neq 0$, Fredholm's solution of Dirichlet's problem and Neumann's problem, Lemmas on iterations of symmetric kernel, Schwarz's inequality and its applications.	Simple variational problems, Necessary condition for an extremum, Euler's equation, End point problem, Variational derivative, Invariance of Euler's equation, Fixed end point problem for n-unknown functions, Variational problem in parametric form, Functionals depending on higher order derivatives. Euler Lagrange equation, First integral of Euler-Lagrange equation, Geodesics,	The brachistochrone, Minimum surface of revolution, Brachistochrone from a given curve to a fixed point, Snell's law, Fermat's principle and calculus of variations.

Dr. Amrit pal singh **MM- 717 ANALYTIC NUMBER THEORY**	Arithmetical functions: Mobius function, Euler's totient function, Mangoldt function, Liouville's function, The divisor functions, Relation connecting φ and μ, product formula for $\varphi(n)$, Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius inversion formula, Multiplicative functions, Dirichlet multiplication, The inverse of a completely multiplicative function, Generalized convolutions.	Averages of arithmetical functions: The big oh notation, Asymptotic equality of functions, Euler's summation formula, Elementary asymptotic formulas, Average order of $d(n)$, $\varphi(n)$, $\sigma_\alpha(n)$, $\mu(n)$ and $\Lambda(n)$, The Partial sums of a Dirichlet product, applications to $\mu(n)$ and $\Lambda(n)$, Legendre's identity.	Some elementary theorems on the distribution of prime numbers: Chebyshev's functions $\psi(x)$ &$\theta(x)$, Relation connecting $\theta(x)$ and $\Pi(x)$, Abel's identity, equivalent forms of Prime number theorem, inequalities for $\Pi(n)$ and P_n , Shapiro's Tauberian theorem, applications of Shapiro's theorem, Asymptotic formula for the partial sums $\sum_{p\leq x}\frac{1}{p}$. Elementary properties of groups , Characters of finite abelian groups, The character group, Orthogonality relations for characters,	, Dirichlet characters, Dirichlet's theorem for primes of the form 4n-1 and 4n+1, Dirichlet's theorem in primes on Arithmetical progression, Distribution of primes in Arithmetical progression.