SYLLABI AND SCHEME OF EXAMINATIONS
FOR
MASTER OF SCIENCE (MATHEMATICS)

(Based on Curriculum and Credit Framework as per NEP 2020)

With effect from the Academic Session 2025-26

CENTRE FOR DISTANCE AND ONLINE EDUCATION
MAHARSHI DAYANAND UNIVERSITY
ROHTAK (HARYANA)

SCHEME OF EXAMINATIONS
MASTER OF SCIENCE (MATHEMATICS)

Type of Course	Nomenclature of Course	Course Code	Total Credits	Assignment Marks	Term End Examination (Theory) Marks	Total Marks
Semester I (2025-26 Onwards)						
DSC 1	Abstract Algebra	**25MAT201DS01OD**	04	30	70	100
DSC 2	Mathematical Analysis	**25MAT201DS02OD**	04	30	70	100
DSC 3	Complex Analysis	**25MAT201DS03OD**	04	30	70	100
DSC 4	Mathematical Statistics	**25MAT201DS04OD**	04	30	70	100
DSC 5	Analytical Number Theory	**25MAT201DS05OD**	04	30	70	100
SEC1	Advanced Discrete Mathematics	**25MAT201SE01OD**	04	30	70	100
Semester II (2025-26 Onwards)						
DSC 6	Theory of Field Extensions	**25MAT202DS01OD**	04	30	70	100
DSC 7	Measure and Integration Theory	**25MAT202DS02OD**	04	30	70	100
DSC 8	Integral Equations and Calculus of Variations	**25MAT202DS03OD**	04	30	70	100
DSC 9	Operations Research Techniques	**25MAT202DS04OD**	04	30	70	100
DSC 10	Algebraic Number Theory	**25MAT202DS05OD**	04	30	70	100
SEC2	Advanced Complex Analysis	**25MAT202SE01OD**	04	30	70	100

Type of Course	Nomenclature of Course	Course Code	Total Credits	Assignment Marks	Term End Examination (Theory) Marks	Total Marks
Semester III (2026-27 Onwards)						
DSC 11	Functional Analysis	**26MAT203DS01OD**	04	30	70	100
DSC 12	Elementary Topology	**26MAT203DS02OD**	04	30	70	100
DSC 13	Fluid Dynamics	**26MAT203DS03OD**	04	30	70	100
DSC 14	Ordinary Differential Equations	**26MAT203DS04OD**	04	30	70	100
DSC 15	Graph Theory	**26MAT203DS05OD**	04	30	70	100
SEC3	Difference Equations	**26MAT203SE03OD**	04	30	70	100
Semester IV (2026-27 Onwards)						
DSC 16	Inner Product Spaces and Measure Theory	**26MAT204DS01OD**	04	30	70	100
DSC 17	Classical Mechanics	**26MAT204DS02OD**	04	30	70	100
DSC18	Viscous Fluid Dynamics	**26MAT204DS03OD**	04	30	70	100
DSC19	Partial Differential Equations	**26MAT204DS04OD**	04	30	70	100
DSC20	General Topology	**26MAT204DS05OD**	04	30	70	100
SEC4	Coding Theory	**26MAT204SE03OD**	04	30	70	100

PLO Code	Program Learning Outcome (PLO)	Description
PLO1	Core Mathematical Principles	Effectively apply fundamental concepts from pure and applied mathematics, including algebra, calculus, differential equations, discrete mathematics, geometry, analysis, numerical analysis, probability and statistics etc.
PLO2	Analytical Problem-Solving	Build strong analytical and abstract thinking skills to solve problems effectively using a range of mathematical techniques.
PLO3	Applied Quantitative Modeling	Construct and critically analyze mathematical models to address real-world challenges across various domains like physics, engineering, and biology.
PLO4	Bridging Disciplines	Seamlessly integrate mathematical principles with other disciplines, such as Computer Science and Statistics, to solve complex problems.
PLO5	Spatial & Structural Insight	Analyze intricate geometric structures and thoroughly explore the properties of topological spaces.
PLO6	Practical Problem Solving	Translate practical business and industrial problems into robust mathematical models and derive effective solutions.
PLO7	Technology Fluency	Demonstrate broad proficiency with key technologies, including SQL, C/ C++ Language, MATLAB, Data Communication and Networking, Data Structure and Computer Graphics.
PLO8	Continuous Learning & Professional Development	Actively engage in continuous learning to stay current with advancements in mathematical sciences and related fields.
PLO9	Computational Proficiency	Proficiently use modern software tools, such as MATLAB and Python, for the effective computation and resolution of mathematical problems.
PLO10	Research & Project Skills	Conduct independent research and projects, effectively interpreting and clearly communicating complex mathematical ideas.

SEMESTER - I

Semester - I

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Abstract Algebra**	**Course Code**	**25MAT201DS01OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Apply group theoretic reasoning to group actions.	PLO2
CLO 2: Learn properties and analysis of solvable & nilpotent groups, Noetherian & Artinian modules and rings.	PLO1
CLO 3: Apply Sylow's theorems to describe the structure of some finite groups and use the concepts of isomorphism and homomorphism for groups and rings.	PLO1, PLO2
CLO 4: Use various canonical types of groups and rings - cyclic groups and groups of permutations, polynomial rings and modular rings.	PLO1
CLO 5: Analyze and illustrate examples of composition series, normal series, subnormal series.	PLO1, PLO2

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Sylow theorems: p-groups, Sylow subgroups, Applications of Sylow theorems, Description of group of order p^2 and pq, Survey of groups upto order 15.

Section-II

Normal and subnormal series, Solvable series, Derived series, Solvable groups, Solvability of S_n-the symmetric group of degree $n \geq 2$, Central series, Nilpotent groups and their properties, Equivalent conditions for a finite group to be nilpotent, Composition series, Zassenhaus lemma, Jordan-Holder theorem.

Section-III

Modules, Cyclic modules, Simple and semi-simple modules, Schurs' lemma, Free modules, Modules over principal ideal domain and its applications to finitely generated abelian groups.

Section-IV

Noetherian and Artinian modules, Modules of finite length, Noetherian and Artinian rings, Hilbert basis theorem. $Hom_R(R,R)$, Nil and Nilpotent ideals, Opposite rings, Wedderburn – Artin theorem.

References:

1. **I**.S. Luther and I.B.S.Passi, Algebra, Vol. I-Groups, Vol. III-Modules, Narosa Publishing House (Vol. I – 2013, Vol. III –2013).
2. Charles Lanski, Concepts in Abstract Algebra, American Mathematical Society, First Indian Edition, 2010.
3. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
4. D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, International Edition, 1997.
5. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
6. C. Musili, Introduction to Rings and Modules, Narosa Publication House, 1994.
7. N. Jacobson, Basic Algebra, Vol. I & II, W.H Freeman, 1980 (also published by Hindustan Publishing Company).
8. M. Artin, Algebra, Prentice-Hall of India, 1991.
9. Ian D. Macdonald, The Theory of Groups, Clarendon Press, 1968.

Semester - I

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Mathematical Analysis**	**Course Code**	**25MAT201DS02OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand Riemann Stieltjes integral, its properties and rectifiable curves.	PLO1
CLO 2: Learn about pointwise and uniform convergence of sequence and series of functions and various tests for uniform convergence.	PLO1
CLO 3: Examine the impact of uniform convergence on continuity and differentiability of limit functions.	PLO2
CLO 4: Work with power series, convergence theorems and functions of several variables, apply concepts like partial derivatives, linear tansformation and differential mappings in R^n..	PLO2, PLO4
CLO 5: Apply Taylor's theorem, implicit/explicit differential and optimization techniques including Lagrange multipliers and Jacobian for functions of several variables..	PLO2, PLO4

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections.Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Riemann-Stieltjes integral, Existence and properties, Integration and differentiation, The fundamental theorem of calculus, Integration of vector-valued functions, Rectifiable curves.

Section-II

Sequence and series of functions, Point wise and uniform convergence, Cauchy criterion for uniform convergence, Weirstrass Mtest, Abel and Dirichlet tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiation, Weierstrass approximation theorem.

Section-III

Power series, uniform convergence and uniqueness theorem, Abel theorem, Tauber theorem.
Functions of several variables, Linear Transformations, Euclidean space R^n, Derivatives in an open subset of R^n, Chain Rule, Partial derivatives, Continuously Differentiable Mapping, Young and Schwarz theorems.

Section-IV

Taylor theorem, Higher order differentials, Explicit and implicit functions, Implicit function theorem, Inverse function theorem, Change of variables, Extreme values of explicit functions, Stationary values of implicit functions, Lagrange multipliers method, Jacobian and its properties.

References:

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, 1976, International Student Edition.
2. T. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1974.
3. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
4. G. De Barra, Measure Theory and Integration, Wiley Eastern Limited, 1981.
5. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd, 1976.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition, 2011.
7. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi, 2012

Semester - I

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Complex Analysis**	**Course Code**	**25MAT201DS03OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**
Course Learning Outcomes (CLO)			**Mapped PLOs**
CLO 1: Be familiar with complex numbers and their geometrical interpretations.			PLO1
CLO 2: Understand the concept of complex numbers as an extension of the real numbers.			PLO1
CLO 3: Represent the sum function of a power series as an analytic function.			PLO1
CLO 4: Demonstrate the ideas of complex differentiation and integration for solving related problems and establishing theoretical results.			PLO1
CLO 5: Understand concept of residues, evaluate contour integrals and solve polynomial equations.			PLO1

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Function of a complex variable, Continuity, Differentiability, Analytic functions and their properties, Cauchy-Riemann equations in cartesian and polar coordinates, Power series, Radius of convergence, Differentiability of sum function of a power series, Branches of many valued functions with special reference to argz, logz and z^a.

Section-II

Path in a region, Contour, Complex integration, Cauchy theorem, Cauchy integral formula, Extension of Cauchy integral formula for multiple connected domain, Poisson integral formula, Higher order derivatives, Complex integral as a function of its upper limit, Morera theorem, Cauchy inequality, Liouville theorem, Taylor theorem.

Section-III

Zeros of an analytic function, Laurent series, Isolated singularities, Cassorati-Weierstrass theorem, Limit point of zeros and poles. Maximum modulus principle, Schwarz lemma, Meromorphic functions, Argument principle, Rouche theorem, Fundamental theorem of algebra, Inverse function theorem.

Section-IV

Calculus of residues, Cauchy residue theorem, Evaluation of integrals of the types $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$, $\int_{-\infty}^{\infty} f(x)dx$, $\int_0^{\infty} f($[illegible]$) \sin mx\, dx$ and $\int_0^{\infty} f(x) \cos mx\, dx$, Conformal mappings.

Space of analytic functions and their completeness, Hurwitz theorem, Montel theorem, Riemann mapping theorem.

References:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of One Complex Variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 2002.
3. Liang-Shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
4. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London, 1972.
5. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London, 1939.
6. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company, 2009.
7. H.S. Kasana, Complex Variable Theory and Applications, PHI Learning Private Ltd, 2011.
8. Dennis G. Zill and Patrik D. Shanahan, A First Course in Complex Analysis with Applications, John Bartlett Publication, 2nd Edition, 2010.

Semester - I

Name of Program	Master of Science (Mathematics)	Program Code	
Name of the Course	**Mathematical Statistics**	**Course Code**	**25MAT201DS04OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	Mapped PLOs
CLO 1: Understand the mathematical basis of probability and its applications in various fields of life.	PLO1, PLO4, PLO8
CLO 2: Use and apply the concepts of probability mass/density functions for the problems involving single/bivariate random variables.	PLO1, PLO2
CLO 3: Have competence in practically applying the discrete and continuous probability distributions along with their properties.	PLO2, PLO8
CLO 4: Formulate hypothesis tests by defining null and alternative hypotheses, specifying critical regions, and distinguishing types of errors.	PLO1, PLO2
CLO 5: Decide as to which test of significance is to be applied for any given large sample problem.	PLO2, PLO6, PLO8, PLO10

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing eight short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Probability: Definition and various approaches of probability, Addition theorem, Boole inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes theorem and its applications.

Section-II

Random variable and probability functions: Definition and properties of random variables, Discrete and continuous random variables, Probability mass and density functions, Distribution function. Concepts of bivariate random variable: joint, marginal and conditional distributions.

Mathematical expectation: Definition and its properties. Variance, Covariance, Moment generating function- Definitions and their properties.

Section-III

Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties.

Continuous distributions: Uniform, Exponential and Normal distributions with their properties.

Section-IV

Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error of estimate, Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors.

Tests of significance: Large sample tests for single mean, Single proportion, Difference between two means and two proportions

References:

1. I V. Hogg and T. Craig, Introduction to Mathematical Statistics , 7th addition, Pearson Education Limited-2014
2. A.M. Mood, F.A. Graybill, and D.C. Boes, Introduction to the Theory of Statistics, Mc Graw Hill Book Company.
3. J.E. Freund, Mathematical Statistics, Prentice Hall of India-2013.
4. M. Speigel, Probability and Statistics, Schaum Outline Series-2017.
5. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand Pub., New Delhi.

Semester - I

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Analytical Number Theory**	**Course Code**	**25MAT201DS05OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Know about the classical results related to prime numbers and get familiar with the irrationality of *e* and *Π*.	PLO1
CLO 2: Study the algebraic properties of U_n and Q_n.	PLO1
CLO 3: Learn about the Waring problems and their applicability.	PLO1
CLO 4: Explore concepts of Diophantine equations.	PLO1
CLO 5: Understand the representation of numbers by two or four squares.Apply the theoretical knowledge of number theory to solve real-world problems.	PLO6

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing eight short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Distribution of primes, Fermat and Mersenne numbers, Farey series and some results concerning Farey series, Approximation of irrational numbers by rationals, Hurwitz theorem, Irrationality of e and π.

Section-II

The arithmetic in Z_n, The group U_n, Primitive roots and their existence, the group U_p^n (p-odd) and U_2^n, The group of quadratic residues Q_n , Quadratic residues for prime power moduli and arbitrary moduli, The algebraic structure of U_n and Q_n .

Section-III

Riemann Zeta Function ζ(s) and its convergence, Application to prime numbers,ζ(s) as Euler product, Evaluation of ζ(2) and ζ(2k). Diophantine equations ax + by = c, $x^2+y^2 = z^2$ and $x^4+y^4 = z^4$, The representation of number by two or four squares, Waring problem, Four square theorem, The numbers g(k) & G(k), Lower bounds for g(k) & G(k).

Section-IV

Arithmetic functions ϕ(n), τ(n), σ(n) and $\sigma_k(n)$, U(n), N(n), I(n), Definitions and examples and simple properties, Perfect numbers, Mobius inversion formula, The Mobius function μ_n, The order and average order of the function ϕ(n), τ(n) and σ(n).

References:

1. G.H. Hardy and E.M. Wright, An Introduction to the Theory of Numbers. 2008
2. D.M. Burton, Elementary Number Theory. 2002
3. N.H. McCoy, The Theory of Number by McMillan. 1966
4. I. Niven, I. and H.S. Zuckermann, An Introduction to the Theory of Numbers. 1960
5. A. Gareth Jones and J Mary Jones, Elementary Number Theory, Springer Ed. 1998.

Semester - I

Name of Program	Master of Science (Mathematics)	Program Code	
Name of the Course	**Advanced Discrete Mathematics**	**Course Code**	**25MAT201SE01OD**
Maximum Marks	**100 70 Theory 30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO):	**Mapped PLOs**
CLO 1: Be familiar with fundamental mathematical concepts and terminology of discrete mathematics and discrete structures.	PLO1, PLO2
CLO 2: Express a logic sentence in terms of predicates, quantifiers and logical connectives.	PLO2
CLO 3: Use finite-state machines to model computer operations.	PLO2, PLO4
CLO 4: Apply the rules of inference and contradiction for proofs of various results.	PLO2
CLO 5: Evaluate boolean functions and simplify expressions using the properties of boolean algebra.	PLO1, PLO2

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing eight short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Recurrence Relations and Generating Functions, Some number sequences, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Generating functions, Recurrences and generating functions, Exponential generating functions.

Section-II

Statements Symbolic Representation and Tautologies, Quantifiers, Predicates and validity,

Prepositional Logic.

Lattices as partially ordered sets, their properties, Lattices as Algebraic systems. Sub lattices, Direct products and Homomorphism, Some special lattices e.g. complete, Complemented and Distributive Lattices.

Section-III

Boolean Algebras as Lattices, Various Boolean Identities, The switching Algebra. Example, Subalgebras, Direct Products and Homomorphism, Joint-irreducible elements, Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms,

Sum of Products, Cononical forms, Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates.) The Karnaugh method.

Section-IV

Finite state Machines and their Transition table diagrams, Equivalence of Finite State, Machines, Reduced Machines, Homomorphism. Finite automata, Acceptors, Non-deterministic, Finite Automata and equivalence of its power to that of deterministic Finite automata, Moore and Mealy Machines.

Grammars and Language: Phrase-Structure Grammars, Requiting rules, Derivation, Sentential forms, Language generated by a Grammar, Regular, Context -Free and context sensitive grammars and Languages, Regular sets, Regular Expressions and the pumping Lemma.

References:

1. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, Fourth Edition. 8th edition 2019
2. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co, New York. 2007
3. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics, Pearson, Fifth Edition. 2017
4. J.P. Tremblay, R. Manohar, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt.Ltd. 1975
5. J.E. Hopcraft and J.D. Ullman, Introduction to Automata Theory, Langauages and Computation, Narosa Publishing House. 2001
6. M. K. Das, Discrete Mathematical Structures for Computer Scientists and Engineers, Narosa Publishing House. 2007
7. C. L. Liu and D.P. Mohapatra, Elements of Discrete Mathematics- A Computer Oriented Approach, Tata McGraw-Hill, Fourth Edition. 2011

SEMESTER - II

Semester - II

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Theory of Field Extensions**	**Course Code**	**25MAT202DS01OD**
Maximum Marks	**100 70 Theory 30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Use diverse properties of field extensions in various areas.	PLO1
CLO 2: Establish the connection between the concept of field extensions and Galois theory.	PLO1, PLO2
CLO 3: Describe the concept of automorphism, monomorphism and their linear independence in field theory.	PLO1
CLO 4: Compute the Galois group for several classical situations.	PLO2, PLO1
CLO 5: Solve polynomial equations by radicals along with the understanding of ruler and compass constructions.	PLO2, PLO1

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections.Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Extension of fields: Elementary properties, Simple Extensions, Algebraic and transcendental Extensions. Factorization of polynomials.

Section-II

Splitting fields, Algebraically closed fields, Separable extensions, Galios fields, Perfect fields.

Section-III

Galios theory: Automorphism of fields, Monomorphisms and their linear independence, Fixed fields.

Section-IV

Normal extensions, Normal closure of an extension, The fundamental theorem of Galois theory.

References:

1. I.S. Luther and I.B.S. Passi, Algebra, Vol. IV-Field Theory, Narosa Publishing House, 2012.
2. Ian Stewart, Galios Theory, Chapman and Hall/CRC, 2004.
3. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
4. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
5. S. Lang, Algebra, 3rd editioin, Addison-Wesley, 1993.
6. Ian T. Adamson, Introduction to Field Theory, Cambridge University Press, 1982.
7. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.

Semester - II

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Measure and Integration Theory**	**Course Code**	**25MAT202DS02OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand the fundamental concept of measure and Lebesgue measure.	PLO1
CLO 2: Characterize measurable functions, discussing equivalent definitions and foundational properties.	PLO1
CLO 3: Distinguish convergence modes (pointwise, almost uniform, in measure) and apply convergence theorems (e.g., Riesz's theorem).	PLO2
CLO 4: Describe the shortcomings of Riemann integral and benefits of Lebesgue integral.	PLO1
CLO 5: Learn about the differentiation of monotonic function, indefinite integral, use of the fundamental theorem of calculus.	PLO1

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Set functions, Intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of aset of real numbers, Algebra of measurable sets, Borel set, Equivalent formulation of measurable set sin terms of open, Closed, F_σ and G_δ sets, Non measurable sets.

Section-II

Measurable functions and their equivalent formulations. Properties of measurable functions. Approximation of a measurable function by a sequence of simple functions, Measurable functions as nearly continuous functions, Egoroff theorem, Lusin theorem, Convergence in measure and F. Riesz theorem. Almostun iform convergence.

Section-III

Short comings of Riemann Integral, Lebesgue Integral of a bounded function over a set of finite measure and its properties. Lebesgue integral as a generalization of Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions, Integral of non-negative functions, Fatou Lemma, Monotone convergence theorem, General Lebesgue Integral, Lebesgue convergence theorem.

Section-IV

Vitali covering lemma, Differentiation of monotonic functions, Function of bounded variation and its representation as difference of monotonic functions, Differentiation of indefinite integral, Fundamental theorem of calculus, Absolutely continuous functions and their properties.

References:

1. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha, , International Student Edition, 1976.
2. H.L. Royden, Real Analysis, Macmillan Pub. Co., Inc. 4th Edition, New York, 1993.
3. P. K. Jain and V. P. Gupta, Lebesgue Measure and Integration, New Age International (P) Limited Published, New Delhi, 1986.
4. G.De Barra, Measure Theory and Integration, Wiley Eastern Ltd., 1981.
5. R.R. Goldberg, Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd, 1976.
6. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition, 2011.

Semester - II

Name of Program	Master of Science (Mathematics)	Program Code	
Name of the Course	**Integral Equations and Calculation of Variations**	**Course Code**	**25MAT202DS03OD**
Maximum Marks	**100 70 Theory 30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	Mapped PLOs
CLO 1: Understand and apply the concepts of Integral Equations including Abel's, Fredholm and Volterra equations.	PLO1, PLO2
CLO 2: Solve integral equations by various methods such as successive approximations, Neumann series and resolvent kernel.	PLO2, PLO6
CLO 3: Demonstrate the knowledge of Euler-Lagrange equations for different forms of functionals.	PLO1, PLO8
CLO 4: Familiar with isoperimetric problem and its solutions.	PLO2
CLO 5: Apply these concepts to solve engineering and other applied problems.	PLO3, PLO6

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Linear Integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series. Laplace transfrom method for a difference kernel. Solution of a Volterra integral equation of the first kind.

Section-II

Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm equations of second kind, Iterated kernels and Neumann series for Fredholm equations. Resolvent kernel as a sum of series. Fredholm resolvent kernel as a ratio of two series. Fredholm equations with separable kernels. Approximation of a kernel by a separable kernel, Fredholm Alternative, Non homonogenous Fredholm equations with degenerate kernels.

Section-III

Green function, Use of method of variation of parameters to construct the Green function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green function, Alternate procedure for construction of the Green function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green function, Hilbert-Schmidt theory for symmetric kernels.

Section-IV

Motivating problems of calculus of variations, Shortest distance, Minimum surface of resolution, Brachistochrone problem, Isoperimetric problem, Geodesic. Fundamental lemma of calculus of variations, Euler equation for one dependent function and its generalization to 'n' dependent functions and to higher order derivatives. Conditional extremum under geometric constraints and under integral constraints.

References:

1. A.J. Jerri, I*ntroduction to Integral Equations with Applications,* A Wiley-Interscience Publication, 1999.
2. R.P. Kanwal, L*inear Integral Equations*, Theory and Techniques, Academic Press, New York.
3. W.V. Lovitt, L*inear Integral Equations*, McGraw Hill, New York.
4. F.B. Hilderbrand, M*ethods of Applied Mathematics*, Dover Publications.
5. J.M. Gelfand and S.V. Fomin, C*alculus of Variations*, Prentice Hall, New Jersy, 1963.

Semester - II

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Operations Research Techniques**	**Course Code**	**25MAT202DS04OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Formulate and solve Linear Programming Problems using various techniques such as graphical method, simplex method, and dual simplex method.	PLO2, PLO3
CLO 2: Understand and apply the concepts of transportation and assignment problems.	PLO1, PLO3
CLO 3: Learn about game theory and its applications in decision-making.	PLO3, PLO6, PLO8
CLO 4: Apply the knowledge of queuing theory to model and analyze waiting lines.	PLO1, PLO3, PLO4
CLO 5: Solve real-world problems in various fields using operations research techniques.	PLO6, PLO8

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections.Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Operations Research: Origin, Definition and scope.
Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two-phase methods, Degeneracy, Duality in linear programming.

Section-II

Transportation Problems: Basic feasible solutions, Optimum solution by stepping stone and modified distribution methods, Unbalanced and degenerate problems, Transhipment problem. Assignment problems: Hungarian method, Unbalanced problem, Case of maximization, Travelling salesman and crew assignment problems.

Section-III

Concepts of stochastic processes, Poisson process, Birth-death process, Queuing models: Basic components of a queuing system, Steady-state solution of Markovian queuing models with single and multiple servers (M/M/1. M/M/C, M/M/1/k, M/MC/k)

Section-IV

Inventory control models: Economic order quantity(EOQ) model with uniform demand, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.

Game Theory : Two person zero sum game, Game with saddle points, The rule of dominance; Algebric, Graphical and linear programming methods for solving mixed strategy games

References:

1. H.A. Taha, Operation Research-An introducton, Printice Hall of India.2017
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.1992
3. S.D. Sharma, Operation Research, Kedar Nath Ram Nath Publications.1992
4. J.K. Sharma, Mathematical Model in Operation Research, Tata McGraw Hill.1989

Semester - II

Name of Program	Master of Science (Mathematics)	Program Code	
Name of the Course	Algebraic Number Theory	Course Code	25MAT202DS05OD
Maximum Marks	100 70 Theory 30 Assignment	Credits	4
		Time of Examinations	03 Hours

Course Learning Outcomes (CLO)	Mapped PLOs
CLO 1: Understand number fields, algebraic integers, and integral bases.	PLO1
CLO 2: Describe units in quadratic and cyclotomic fields and demonstrate their properties.	PLO1
CLO 3: Analyze the factorization of ideals and Dedekind domains.	PLO2
CLO 4: Understand the concepts of unique factorization, class group, and class number.	PLO1
CLO 5: Understand ramified and unramified extensions and their related results.	PLO2

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Algebraic Number and Integers : Gaussian integers and its properties, Primes and fundamental theorem in the ring of Gaussian integers, Integers and fundamental theorem in Q(ω) where $\omega^3 = 1$, Algebraic fields, Primitive polynomials, The general quadratic field Q(√m), Sections of Q(√2), Fields in which fundamental theorem is false, Real and complex Euclidean fields, Fermat theorem in the ring of Gaussian integers, Primes of Q(√2) and Q(√5).

Section-II

Countability of set of algebraic numbers, Liouville theorem and generalizations, Transcendental numbers, Algebraic number fields, Liouville theorem of primitive elements, Ring of algebraic integers, Theorem of primitive elements.

Section-III

Norm and trace of an algebraic number, Non degeneracy of bilinear pairing, Existence of an integral basis, Discriminant of an algebraic number field, Ideals in the ring of algebraic integers, Explicit construction of integral basis, Sign of the discriminant, Cyclotomic fields, Calculation for quadratic and cubic cases.

Section-IV

Integral closure, Noetherian ring, Characterizing Dedekind domains, Fractional ideals and unique factorization, G.C.D. and L.C.M. of ideals, Chinese remainder theorem, Dedekind theorem, Ramified and unramified extensions, Different of an algebraic number field, Factorization in the ring of algebraic integers.

References:

1. Esmonde and M Ram Murty, Problems in Algebraic Number Theory, GTM Vol. 190, Springer Verlag, 1999.
2. G.H. Hardy and E.M. Wright, An Introduction to the Theory of Numbers 2008
3. W.J. Leveque, Topics in Number Theory – Vols. I, III Addition Wesley. 2012
4. H. Pollard, The Theory of Algebraic Number, Carus Monogrpah No. 9, Mathematical Association of America. 1998
5. P. Riebenboim, Algebraic Numbers – Wiley Inter-science. 1972
6. E. Weiss, Algebraic Number Theory, McGraw Hill. 2012

Semester - II

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Advanced Complex Analysis**	**Course Code**	**25MAT202SE01OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**4**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO):	**Mapped PLOs**
CLO 1: Understand the concepts of Gamma function and its properties.	PLO1
CLO 2: Get familiar with Riemann Zeta function, Riemann functional equation and Mittag Leffler theorem.	PLO2
CLO 3: Demonstrate the idea of Harnack Inequality, Dirichlet region, Green function and its properties.	PLO1
CLO 4: Understand the concept of integral functions, their factorization, order and exponent of convergence.	PLO1
CLO 5: Be familiar with the range of analytic functions and proof of related results.	PLO1, PLO2

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Integral Functions, Factorization of an integral function, Weierstrass primary factors, Weierstrass' factorization theorem, Gamma function and its properties, Stirling formula, Integral version of gamma function, Riemann Zeta function, Riemann functional equation, Mittag-Leffler theorem, Runge theorem(Statement only).

Section-II

Analytic Continuation, Natural Boundary, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Schwarz Reflection principle, Germ of an analytic function.

Monodromy theorem and its consequences, Harmonic functions on a disk, Poisson kernel, The Dirichlet problem for a section disc

Section-III

Harnack inequality, Harnack theorem, Dirichlet region, Green function, Canonical product, Jensen formula, Poisson-Jensen formula, Hadamard three circles theorem, Growth and order of an entire function, An estimate of number of zeros, Exponent of convergence, Borel theorem, Hadamard factorization theorem.

Section-IV

The range of an analytic function, Bloch theorem, Schottky theorem, Little Picard theorem, Montel Caratheodory theorem, Great Picard theorem, Univalent functions, Bieberbach conjecture(Statement only) and the "1/4 theorem"

References:

1. H.A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 2011.
3. J.B. Conway, Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 2002.
4. Liang-shin Hann & Bernand Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
5. E.T. Copson, An Introduction to the Theory of Functions of a Complex Variable, Oxford University Press, London.
6. E.C. Titchmarsh, The Theory of Functions, Oxford University Press, London.
7. Mark J. Ablowitz and A.S. Fokas, Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
8. Ruel V. Churchill and James Ward Brown, Complex Variables and Applications, McGraw-Hill Publishing Company.
9. H.S. Kasana, Complex Variable Theory and Applications, PHI Learning Private Ltd, 2011.

SEMESTER - III

Semester - III

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Functional Analysis**	**Course Code**	**26MAT203DS01OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand the concepts of normed spaces and illustrate them with examples.	PLO1
CLO 2: Understand the concepts of bounded linear transformation, equivalent formulation of continuity and spaces of bounded linear transformations	PLO1, PLO5
CLO 3: Describe the solvability of linear equations in Banach Spaces, weak and strong convergence and their equivalence in finite dimensional space.	PLO1, PLO5
CLO 4: Understand the concept of linear transformations and their boundedness, continuity and adjoint.	PLO1, PLO5
CLO 5: Analyze the properties of compact operators and relate them to integral equations.	PLO1, PLO2

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Normed linear spaces, Metric on normed linear spaces, Completion of a normed space, Banach spaces, subspace of a Banach space, Holder and Minkowski inequality, Completeness of quotient spaces of normed linear spaces. Completeness of l_p, L^p, R^n, C^n and C[a,b]. Incomplete normed spaces.

Section-II

Finite dimensional normed linear spaces and Subspaces, Bounded linear transformation, Equivalent formulation of continuity, Spaces of bounded linear transformations, Continuous linear functional, Conjugate spaces. Hahn-Banach extension theorem (Real and Complex form).

Section-III

Riesz Representation theorem for bounded linear functionals on L^p and C[a,b]. Second conjugate spaces, Reflexive space, Uniform boundedness principle and its consequences, Open mapping theorem and its application,Projections, Closed Graph theorem.

Section-IV

Equivalent norms, Weak and Strong convergence, Their equivalence in finite dimensional spaces. Weak sequential compactness, Solvability of linear equations in Banach spaces.

Compact operator and its relation with continuous operator, Compactness of linear transformation on a finite dimensional space, Properties of compact operators, Compactness of the limit of the sequence of compact operators.

References:

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.
2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley,1978
3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
4. A. H. Siddiqi, Khalil Ahmad and P. Manchanda, Introduction to Functional Analysis with Applications, Anamaya Publishers, New Delhi-2006.
5. K.C. Rao, Functional Analysis, Narosa Publishing House, Second edition, 2006

Semester - III

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Elementary Topology**	**Course Code**	**26MAT203DS02OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand the concept of topological spaces, continuous functions, compactness and connectedness.	PLO1, PLO5
CLO 2: Learn about separation axioms T0, T1, T2 and their basic properties.	PLO1, PLO5
CLO 3: Describe the concept of homeomorphism and topological invariants.	PLO1, PLO5
CLO 4: Be familiar with the concepts of compact spaces and locally compact spaces.	PLO1, PLO5
CLO 5: Understand the concepts of connected spaces.	PLO1, PLO5

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Definition and examples of topological spaces, Comparison of topologies on a set, Intersection and union of topologies on a set, Neighbourhoods, Interior point and interior of a set, Closed set as a complement of an open set, Adherent point and limit point of a set, Closure of a set, Derived set, Properties of Closure operator, Boundary of a set, Dense subsets, Interior, Exterior and boundary operators, Alternative methods of defining a topology in terms of neighbourhood system and Kuratowski closure operator.

Section-II

Relative (Induced) topology, Base and subbase for a topology, Base for Neighbourhood system. Continuous functions, Open and closed functions, Homeomorphism. Connectedness and its characterization, Connected subsets and their properties, Continuity and connectedness, Components, Locally connected spaces.

Section-III

Compact spaces and subsets, Compactness in terms of finite intersection property, Continuity and compact sets, Basic properties of compactness, Closeness of compact subset and a continuous map from a compact space into a Hausdorff and its consequence. Sequentially and countably compact sets, Local compactness and one point compatification.

Section-IV

First countable, Second countable and separable spaces, Hereditary and topological property, Countability of a collection of disjoint open sets in separable and second countable spaces, Lindelof theorem. T_0, T_1, T_2 (Hausdorff) separation axioms, their characterization and basic properties.

References:

1. C.W.Patty, Foundation of Topology, Jones & Bertlett, 2009.
2. Fred H. Croom, Principles of Topology, Cengage Learning, 2009.
3. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
4. J. L. Kelly, General Topology, Springer Verlag, New York, 2000.
5. J. R. Munkres, Toplogy, Pearson Education Asia, 2002.
6. K. Chandrasekhara Rao, Topology, Narosa Publishing House Delhi,2009.
7. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, 2006.

Semester - III

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Fluid Dynamics**	**Course Code**	**26MAT203DS03OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Be familiar with continuum model of fluid flow and classify fluid/flows based on physical properties of a fluid/flow along with Eulerian and Lagrangian descriptions of fluid motion.	PLO1, PLO3, PLO4, PLO6, PLO8
CLO 2: Derive and solve equation of continuity, equations of motion, vorticity equation, equation of moving boundary surface, pressure equation and equation of impulsive action for a moving inviscid fluid.	PLO1, PLO3, PLO10
CLO 3: Calculate velocity fields and forces on bodies for simple steady and unsteady flow including those derived from potentials.	PLO1, PLO2, PLO3
CLO 4: Understand the concepts of velocity potential, stream function and complex potential, and their use in solving two-dimensional flow problems applying complex-variable techniques.	PLO1, PLO6
CLO 5: Represent mathematically the potentials of source, sink and doublets in two-dimensions as well as three-dimensions, and study their images in impermeable surfaces.	PLO1, PLO8

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Kinematics - Velocity at a point of a fluid. Eulerian and Lagrangian methods. Stream lines, path lines and streak lines. Velocity potential. Irrotational and rotational motions. Vorticity and circulation. Equation of continuity. Boundary surfaces. Acceleration at a point of a fluid. Components of acceleration in cylindrical and spherical polar co-ordiantes.

Section-II

Pressure at a point of a moving fluid. Euler equation of motion. Equations of motion in cylindrical and spherical polar co-ordinates.

Bernoulli equation. Impulsive motion. Kelvin circulation theorem. Vorticity equation. Energy equation for incompressible flow. Kinetic energy of irrotational flow. Kelvin minimum energy theorem. Kinetic energy of infinite fluid. Uniqueness theorems.

Section-III

Axially symmetric flows. Liquid streaming part a fixed sphere. Motion of a sphere through a liquid at rest at infinity. Equation of motion of a sphere. Kinetic energy generated by impulsive motion. Motion of two concentric spheres. Three-dimensional sources, sinks and doublets. Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surface.

Section-IV

Two dimensional motion; Use of cylindrical polar co-ordinates. Stream function. Axisymmetric flow. Stoke stream function. Stoke stream function of basic flows.

Irrotational motion in two-dimensions. Complex velocity potential. Milne-Thomson circle theorem. Two-dimensional sources, sinks, doublets and their images. Blasius theorem.

References:

1. W.H. Besaint and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers, Delhi, 1988.
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
3. O'Neill, M.E. and Chorlton, F., Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.
4. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
5. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

Semester - III

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Ordinary Differential Equations**	**Course Code**	**26MAT203DS04OD**
Maximum Marks	**100 70 Theory 30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Apply differential equations to variety of problems in diversified fields of life.	PLO1, PLO4, PLO6
CLO 2: Learn use of differential equations for modeling and solving real life problems.	PLO1, PLO3, PLO6
CLO 3: Interpret the obtained solutions in terms of the physical quantities involved.	PLO2, PLO6
CLO 4: Investigate nonlinear conservative systems and study their behavior.	PLO1, PLO2
CLO 5: Use various methods of approximation for qualitative understanding of solutions.	PLO1, PLO2

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Preliminaries, ε-approximate solution, Cauchy-Euler construction of an ε-approximate solution of an initial value problem, Equicontinuous family of functions, Ascoli-Arzela Lemma, Cauchy-Peano existence theorem.

Lipschitz condition, Picards-Lindelof existence and uniqueness theorem for dy/dt =f(t,y), Solution of initial-value problems by Picards method, Dependence of solutions on initial conditions ***(Relevant topics from the books by Coddington & Levinson, and Ross)***.

Section-II

Linear systems, Matrix method for homogeneous first order system of linear differential equations, Fundamental set of solutions, Fundamental matrix of solutions, Wronskian of solutions, Basic theory of the homogeneous linear system, Abel-Liouville formula, Non-homogeneous linear system.

Strum Theory, Self-adjoint equations of the second order, Abel formula, Strum Separation theorem, Strum Fundamental comparison theorem.

(Relevant topics from chapters 7 and 11 of book by Ross)

Section-III

Nonlinear differential systems, Phase plane, Path, Critical points, Autonomous systems, Isolated critical points, Path approaching a critical point, Path entering a critical point, Types of critical points- Center, Saddle points, Spiral points, Node points, Stability of critical points, Asymptotically stable points, Unstable points, Critical points and paths of linear systems. Almost linear systems. **(Relevant topics from chapter 13 of book by Ross)**.

Section-IV

Nonlinear conservative dynamical system, Dependence on a parameter, Liapunov direct method, Limit cycles, Periodic solutions, Bendixson nonexistence criterion, Poincore- Bendixson theorem(statement only), Index of a critical point.

Strum-Liouville problems, Orthogonality of characteristic functions. **(Relevant topics from chapters 12 and 13 of the book by Ross)**.

References:

1. E.A. Coddington and N. Levinson, *Theory of ordinary differential equations*, Tata McGraw Hill, 2000.
2. S.L. Ross*, Differential equations*, John Wiley and Sons Inc., New York, 1984.
3. W.E. Boyce and R.C. Diprima, E*lementary differential equations and boundary value problems*, John Wiley and Sons, Inc., New York, 4th edition, 1986.
4. G.F. Simmon, *Differential Equations*, Tata McGraw Hill, New Delhi, 1993.

Semester - III

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Graph Theory**	**Course Code**	**26MAT203DS05OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand fundamental concepts of graph theory and apply them.	PLO1, PLO2
CLO 2: Learn about different types of graphs and their properties.	PLO1
CLO 3: Be familiar with trees, spanning trees and their applications.	PLO1, PLO4
CLO 4: Solve problems involving vertex, edge connectivity, planarity and edge coloring.	PLO1, PLO2, PLO9
CLO 5: Apply tree and graph algorithms to solve problems.	PLO3, PLO6

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections.Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Definition and types of graphs, Walks, Paths and Circuits, Connected and Disconnected graphs, Applications of graphs, operations on Graphs, Graph Representation, Isomorphism of Graphs.

Section-II

Eulerian and Hamiltonian paths, Shortest Path in a Weighted Graph, The Travelling Salesperson Problem, Planar Graphs, Detection of Planarity and Kuratowski Theorem, Graph Colouring.

Section-III

Directed Graphs, Trees, Tree Terminology, Rooted Labeled Trees, Prefix Code, Binary Search Tree, Tree Traversal.

Section-IV

Spanning Trees and Cut Sets, Minimum Spanning Trees, Kruskal Algorithm, Prim Algorithm, Decision Trees, Sorting Methods.

References:

1. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice –Hall of India Pvt. Ltd, 2004.
2. F. Harary: Graph Theory, Addition Wesley, 1969.
3. G. Chartrand and P. Zhang. Introduction to Graph Theory, Tata McGraw-Hill, 2006.
4. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, Fourth Edition, 1999.
5. Seymour Lipschutz and Marc Lipson, Theory and Problems of Discrete Mathematics, Schaum Outline Series, McGraw-Hill Book Co, New York, 2007.
6. John A. Dossey, Otto, Spence and Vanden K. Eynden, Discrete Mathematics, Pearson, Fifth Edition, 2005.
7. C. L. Liu and D.P.Mohapatra, Elements of Discrete Mathematics- A Computer Oriented Approach, Tata McGraw-Hill, Fourth Edition, 2017.

Semester - III

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Difference Equations**	**Course Code**	**26MAT203SE03OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand basic concepts of difference equations.	PLO1
CLO 2: Learn methods for solving difference equations.	PLO1, PLO2
CLO 3: Analyze stability of solutions.	PLO2, PLO5
CLO 4: Apply difference equations in modeling phenomena.	PLO3, PLO4, PLO6
CLO 5: Understand the concept of asymptotic methods for linear and nonlinear equations. Also explain the chaotic behaviour of solutions.	PLO3, PLO6

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Difference Calculus: Introduction, The Difference Operator, Summation, Generating functions and Approximate Summation.

Section-II

Linear Difference Equations: First Order Equations, General Results for Linear Equations, Solving Linear Equations, Applications, Equations with Variable Coefficients, Nonlinear Equations that can be Linearized, The z-Transform.

Section-III

Stability Theory: Initial Value Problems for Linear Systems, Stability of Linear Systems, Phase Plane Analysis for Linear Systems, Fundamental Matrices and Floquet Theory, Stability of Nonlinear Systems, Chaotic Behavior.

Section-IV

Asymptotic Methods: Introduction, Asymptotic Analysis of Sums, Linear Equations, Nonlinear Equations.

References:

1. Walter Kelley and Allan Peterson, Difference Equations, An Introduction with Applications, Academic Press, 2001
2. Calvin Ahlbrant and Allan Peterson, Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations, Kluwer (1996).
3. Saber Elaydi, An Introduction to Difference Equations, Springer, 2010.

SEMESTER - IV

Semester - IV

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Inner Product Spaces and Measure Theory**	**Course Code**	**26MAT204DS01OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand the concepts of inner product spaces, Hilbert spaces and their properties.	PLO1, PLO5
CLO 2: Learn about fundamental theorems like Riesz representation theorem and projection theorem.	PLO1, PLO5
CLO 3: Be familiar with the concept of orthonormal sets.	PLO1, PLO5
CLO 4: Understand the concept of linear operators and their properties in Hilbert spaces.	PLO1, PLO5
CLO 5: Analyze the properties of compact and self-adjoint operators.	PLO1, PLO2

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections.Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Hilbert Spaces: Inner product spaces, Hilbert spaces, Schwarz inequality, Hilbert space as normed linear space, Convex sets in Hilbert spaces, Projection theorem, Orthonormal sets, Separability, Total Orthonormal sets, Bessel inequality, Parseval identity.

Section-II

Conjugate of a Hilbert space, Riesz representation theorem in Hilbert spaces, Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert space, Self-adjoint operators, Positive operators, Product of Positive Operators.

Section-III

Projection operators, Product of Projections, Sum and Difference of Projections, Normal and sectionary operators, Projections on Hilbert space, Spectral theorem on finite dimensional space.

Convex functions, Jensen inequalities, Measure space, Generalized Fatou lemma, Measure and outer measure, Extension of a measure, Caratheodory extension theorem.

Section-IV

Signed measure, Hahn decomposition theorem, Jordan decomposition theorem, Mutually signed measure, Radon–Nikodyn theorem, Lebesgue decomposition, Lebesgue-Stieltjes integral, Product measures, Fubini theorem, Baire sets, Baire measure, Continuous functions with compact support.

References:

1. H.L. Royden, Real Analysis, MacMillan Publishing Co., Inc., New York, 4th Edition, 1993.

2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley (1978).

3. S.K. Berberian, Measure and Integration, Chelsea Publishing Company, New York, 1965.

4.George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963
5. K.C. Rao, Functional Analysis, Narosa Publishing House, Second edition, 2006.

Semester - IV

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Classical Mechanics**	**Course Code**	**26MAT204DS02OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand the fundamental principles of classical mechanics.	PLO1, PLO4
CLO 2: Apply Lagrangian and Hamiltonian formulations to solve mechanical problems.	PLO1, PLO3, PLO6
CLO 3: Analyze conservative and non-conservative systems.	PLO2, PLO8, PLO4
CLO 4: Understand ideal constrains, general equation of dynamics and Lagrange's equations for potential forces.	PLO1, PLO8
CLO 5: Be familiar with canonical transformations and Hamilton-Jacobi theory.	PLO1, PLO3

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Moments and products of inertia, Angular momentum of a rigid body, Principal axes and principal moment of inertia of a rigid body, Kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid and equimomental systems, Coplanar mass distributions, General motion of a rigid body. (Relevant topics from the book of Chorlton).

Section-II

Free & constrained systems, Constraints and their classification, Holonomic and non-holonomic systems, Degree of freedom and generalised coordinates, Virtual displacement and virtual work, Statement of principle of virtual work (PVW), Possible velocity and possible acceleration, Ideal constraints**, G**eneral equation of dynamics for ideal constraints, Lagrange equations of the first kind. D' Alembert principle,

Independent coordinates and generalized forces, Lagrange equations of the second kind, Generalized velocities and accelerations. Uniqueness of solution, Variation of total energy for conservative fields. Lagrange variable and Lagrangian function L(t, Q_i, $\dot{q}_i$), Lagrange equations for potential forces, Generalized momenta p_i.

Section-III

Hamiltonian variable and Hamiltonian function, Donkin theorem, Ignorable coordinates, Hamilton canonical equations, Routh variables and Routh function R, Routh equations, Poisson Brackets and their simple properties, Poisson identity, Jacobi – Poisson theorem.

Hamilton action and Hamilton principle, Poincare – Carton integral invariant, Whittaker equations, Jacobi equations, Lagrangian action and the principle of least action.

Section-IV

Canonical transformation, Necessary and sufficient condition for a canonical transformation, Univalent Canonical transformation, Free canonical transformation, Hamilton-Jacobi equation, Jacobi theorem, Method of separation of variables in HJ equation, Lagrange brackets, Necessary and sufficient conditions of canonical character of a transformation in terms of Lagrange brackets, Jacobian matrix of a canonical transformation, Conditions of canonicity of a transformation in terms of Poison brackets, Invariance of Poisson Brackets under canonical transformation.

References:

1. F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
2. P.V. Panat, Classical Mechanics, Narosa Publishing House, New Delhi, 2005.
3. N.C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw- Hill, New Delhi, 1991.
4. Louis N. Hand and Janet D. Finch, Analytical Mechanics, CUP, 1998.
5. K. Sankra Rao, Classical Mechanics, Prentice Hall of India, 2005.
6. M.R. Speigal, Theoretical Mechanics, Schaum Outline Series, 2017.
7. F. Chorlton, Textbook of Dynamics, CBS Publishers, New Delhi, 1985.

Semester - IV

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Viscous Fluid Dynamics**	**Course Code**	**26MAT204DS03OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand the basic concepts of viscous fluid flow.	PLO1, PLO3, PLO4
CLO 2: Model mathematically the compressible fluid flow and describe various aspects of gas flow.	PLO1, PLO2, PLO3
CLO 3: Acquire knowledge of viscosity, relation between shear stress and rates of shear strain for Newtonian fluids, energy dissipation due to viscosity, and laminar and turbulent flows.	PLO1, PLO2, PLO6
CLO 4: Derive the equations of motion for a viscous fluid flow and use them for study of flow Newtonian fluids in pipes and ducts for laminar flow fields, and their applications in mechanical engineering.	PLO1, PLO2, PLO8
CLO 5: Get familiar with dimensional analysis and similitude, and understand the common dimensional numbers of fluid dynamics along with their physical and mathematical significance.	PLO1, PLO3, PLO10

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections.Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Vorticity in two dimensions, Circular and rectilinear vortices, Vortex doublet, Images, Motion due to vortices, Single and double infinite rows of vortices. Karman vortex street.

Wave motion in a Gas. Speed of sound in a gas. Equation of motion of a Gas. Subsonic, sonic and supersonic flows. Isentropic gas flow, Flow through a nozzle.

Section-II

Stress components in a real fluid. Relation between Cartesian components of stress. Translational motion of fluid element. Rates of strain. Transformation of rates of strains. Relation between stresses and rates of strain. The co-efficient of viscosity and laminar flow. Newtonian and non-Newtonian fluids.

Navier-Stoke equations of motion. Equations of motion in cylindrical and spherical polar co-ordinates. Diffusion of vorticity. Energy dissipation due to viscosity.

Section-III

Plane Poiseuille and Couette flows between two parallel plates. Theory of lubrication. Hagen Poiseuille flow. Steady flow between co-axial circular cylinders and concentric rotating cylinders. Flow through tubes of uniform elliptic and equilateral triangular cross-section. Unsteady flow over a flat plate. Steady flow past a fixed sphere. Flow in convergent and divergent chennals.

Section-IV

Dynamical similarity. Inspection analysis. Non-dimensional numbers. Dimensional analysis. Buckingham π-theorem and its application. Physical importance of non-dimensional parameters. Prandtl boundary layer. Boundary layer equation in two-dimensions. The boundary layer on a flat plate (Blasius solution). Characteristic boundary layer parameters. Karman integral conditions. Karman-Pohlhausen method.

References:

1. W.H. Besaint and A.S. Ramasey, A Treatise on Hydromechanics, Part II, CBS Publishers,Delhi, 1988.

2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985

3. O'Neill, M.E. and Chorlton, F., Ideal and Incompressible Fluid Dynamics, Ellis Horwood Limited, 1986.

4. O'Neill, M.E. and Chorlton, F. , Viscous and Compressible Fluid Dynamics, Ellis Horwood Limited, 1989.

5. S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New Delhi, 1976.

6. H. Schlichting, Boundary-Layer Theory, McGraw Hill Book Company, New York, 1979.

7. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.

8. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.

Semester - IV

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Partial Differential Equations**	**Course Code**	**26MAT204DS04OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Classify partial differential equations and understand their origins.	PLO1, PLO3, PLO4
CLO 2: Solve boundary value problems related to Laplace, heat and wave equations by various methods.	PLO1, PLO2
CLO 3: Apply methods to solve second-order PDEs.	PLO1, PLO2, PLO8
CLO 4: Use Green's function method to solve partial differential equations.	PLO1, PLO6
CLO 5: Apply PDEs to solve phenomena like heat conduction and wave propagation.	PLO3, PLO6

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Method of separation of variables to solve Boundary Value Problems (B.V.P.) associated with one dimensional heat equation. Steady state temperature in a rectangular plate, Circular disc, Semi-infinite plate. The heat equation in semi-infinite and infinite regions. Solution of three dimensional Laplace equations, Heat Equations, Wave Equations in cartesian, cylindrical and spherical coordinates. Method of separation of variables to solve B.V.P. associated with motion of a vibrating string. Solution of wave equation for semi-infinite and infinite strings. (Relevant topics from the book by O'Neil)

Section-II

Partial differential equations: Examples of PDE classification. Transport equation – Initial value problem. Non-homogeneous equations.
Laplace equation – Fundamental solution, Mean value formula, Properties of harmonic functions, Green function.

Section-III

Heat Equation – Fundamental solution, Mean value formula, Properties of solutions, Energy methods.
Wave Equation – Solution by spherical means, Non-homogeneous equations, Energy methods.

Section-IV

Non-linear first order PDE – Complete integrals, Envelopes, Characteristics, Hamilton Jacobi equations (Calculus of variations, Hamilton ODE, Legendre transform, Hopf-Lax formula, Weak solutions, Uniqueness).

References:

1. I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, New York, 1957.
2. Peter V. O'Neil, Advanced Engineering Mathematics, ITP, 2017
3. L.C. Evans, Partial Differential Equations: Second Edition (Graduate Studies in Mathematics) 2nd Edition, American Mathematical Society, 2010.
4. H.F. Weinberger, A First Course in Partial Differential Equations, John Wiley & Sons, 1965.
5. M.D. Raisinghania, Advanced Differential equations, S. Chand & Co. 2015.

Semester - IV

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**General Topology**	**Course Code**	**26MAT204DS05OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand general concepts of topological spaces and continuous functions.	PLO1, PLO5
CLO 2: Learn about countability and separation axioms.	PLO1, PLO5
CLO 3: Understand the concept of product topological spaces and their properties.	PLO1, PLO5
CLO 4: Understand connected spaces and path-connected spaces.	PLO1, PLO5
CLO 5: Apply topological concepts to analyze mathematical structures.	PLO1, PLO5

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections.Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

Regular, Normal, T_3 and T_4 separation axioms, Their characterization and basic properties, Urysohn lemma and Tietze extension theorem, Regularity and normality of a compact Hausdorff space, Complete regularity, Complete normality, $T_{3\frac{1}{2}}$ and T_5 spaces, Their characterization and basic properties.

Section-II

Product topological spaces, Projection mappings, Tychonoff product topology in terms of standard subbases and its characterization, Seperation axioms and product spaces, Connectedness, Locally connectedness and compactness of product spaces, Product space as first axiom space, Tychonoff product theorem.
Embedding and Metrization: Embedding lemma and Tychonoff embedding theorem, Metrizable. spaces, Urysohn metrization theorem.

Section-III

Nets : Nets in topological spaces, Convergence of nets, Hausdorffness and nets, Subnet and cluster points, Compactness and nets, Filters : Definition and examples, Collection of all filters on a set as a poset, Methods of generating filters and finer filters, Ultra filter and its characterizations, Ultra filter principle, Image of filter under a function, Limit point and limit of a filter, Continuity in terms of convergence of filters, Hausdorffness and filters, Canonical way of converting nets to filters and vice versa, Stone-Cech compactification(Statement Only).

Section-IV

Covering of a space, Local finiteness, Paracompact spaces, Paracompactness as regular space, Michaell theorem on characterization of paracompactness, Paracompactness as normal space, A. H. Stone theorem, Nagata- Smirnov Metrization theorem.

References:

1.George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963
2.K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. 2017.
3.J. L. Kelly, General Topology, Springer Verlag, New York, 2000.
4.J. R. Munkres, Toplogy, Pearson Education Asia, 2002.
5.W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 1964.
6.K. Chandrasekhara Rao, Topology, Narosa Publishing House Delhi, 2009.
7.Fred H. Croom, Principles of Topology, Cengage Learning, 2009.

Semester - IV

Name of Program	**Master of Science (Mathematics)**	**Program Code**	
Name of the Course	**Coding Theory**	**Course Code**	**26MAT204SE03OD**
Maximum Marks	**100** **70 Theory** **30 Assignment**	**Credits**	**04**
		Time of Examinations	**03 Hours**

Course Learning Outcomes (CLO)	**Mapped PLOs**
CLO 1: Understand coding theory concepts.	PLO1
CLO 2: Learn error-correcting codes.	PLO1, PLO2
CLO 3: Understand encoding and decoding concepts.	PLO1
CLO 4: Be familiar with bounds on code parameters.	PLO1
CLO 5: Apply coding theory to solve real life problems.	PLO6

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question no. 1 will be compulsory containing four short answer type questions from all sections. Further, examiner will set two questions from each section and the candidates will be required to attempt one question from each Section. All questions will carry equal marks.

Section-I

The communication channel, The coding problem, Types of codes, Block codes, Types of codes such as repetition codes, Parity check codes and their error-detection and correction capabilities. Hamming metric, Relationship of error detection/correction with hamming distance, Maximum likelihood decoding procedure, Decoding by syndrome decoding and Coset leaders, Standard array.

Section-II

Linear codes(Binary and non binary), Minimum distance, Dimension, Modular representation of linear codes, Description of linear codes by matrices, Polynomial codes, Generator and parity check polynomials and matrices.

Section-III

Dual codes, Self duality, Weight distribution of dual of binary linear codes, Macwilliam identity(binary case) extending, Expurgating and augmenting a code, Lee metric, Convolutional codes, Description using matrices and polynomials, Encoding using (4,3,2) encoder.

Section-IV

Hamming codes (Binary and non-binary) and their properties, Perfect and quasi-perfect codes. Golaycodes as perfect codes, Bounds on minimum distance for block codes,Plotkin bound, Hamming sphere.

References:

1. Ryamond Hill, A First Course in Coding Theory, Oxford University Press, 1986.
2. Man Young Rhee, Error Correcting Coding Theory, McGraw Hill Inc., 1989.
3. W.W. Peterson and E.J. Weldon, Jr., Error-Correcting Codes. M.I.T. Press, Cambridge Massachuetts, 1972.
4. E.R. Berlekamp, Algebraic Coding Theory, McGraw Hill Inc., 1968.
5. F.J. Macwilliams and N.J.A. Sloane, Theory of Error Correcting Codes, North-Holand Publishing Company. 1981.
6. J.H. Van Lint, Introduction to Coding Theory, Graduate Texts in Mathematics, 86, Springer, 1998.
7. L.R. Vermani, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.