Khandesh College Education Society's

Moolji Jaitha College, Jalgaon

An "Autonomous College" Affiliated to

KBC North Maharashtra University, Jalgaon

KNOWLEDGE IS POWER

ESTD. 1945

SYLLABUS

Mathematics

M. Sc.

(Semester III & IV)

Under Choice Based Credit System (CBCS)

[w. e. f. Academic Year: 2020-21]

Program Specific Outcomes (PSO)

Students who graduate with a Master of Science in Mathematics will:

PSO1: Demonstrate an understanding of concepts involved in mathematical analysis, algebra and applied mathematics.

PSO2: Gain proficiency in mathematical techniques of both pure and applied mathematics and be able to apply the necessary mathematical methods to any scientific problem.

PSO3: Acquire significant knowledge on various aspects related to Linear algebra, Topology, Numerical methods and Differential equations.

PSO4: Learn to work independently as well as a team to formulate appropriate mathematical methods.

PSO5: Develop the ability to understand and practice the morality and ethics regarding scientific Research.

PSO6: Realize the scope of mathematics in enlightening of the society and plan to pursue research which is beneficial to the society.

Course Structure: M.Sc. (Mathematics)

Duration: The duration of M.Sc. (Mathematics) degree program shall be two years.

Term / Semester	Course Module	Subject Code	Title of Paper	Credit	Hours per Week
III	DSC	MT-301	Functional analysis	4	4
	DSC	MT-302	Advanced numerical methods	4	4
	DSC	MT-303	Field theory	4	4
	DSC	MT-304	Lattice theory	4	4
	SEC	MT-305(A)	Combinatorics	4	4
	SEC	MT-305(B)	Fluid dynamics	4	4
	DSE	MT-306(A)	Problem course based on MT-301 and MT-302	4	4
	DSE	MT-306(B)	Problem course based on MT-303 and MT-304	4	4
IV	DSC	MT-401	Linear integral equations	4	4
	DSC	MT-402	Operations research	4	4
	DSC	MT-403	Commutative algebra	4	4
	DSC	MT-404	Advanced ring theory	4	4
	GE	MT-405(A)	Graph theory	4	4
	GE	MT-405(B)	Algebraic topology	4	4
	DSE	MT-406(A)	Problem course based on MT-401 and MT-402	4	4
	DSE	MT-406(B)	Problem course based on MT-403 and MT-404	4	4

DSC: Discipline Specific Elective Core Course; **SEC**: Skill Enhancement Course;
DSE: Discipline Specific Elective (DSE) Course; **GE**: Generic Elective Course
MT- SC: Mathematics (S-Semester; C-Course number)

Examination Pattern for M. Sc.

Nature	Marks
External Marks	**60**
Internal Marks	**40**
Total Marks	**100**

M.Sc. (Mathematics): Semester-III

MT-301: Functional analysis

Total Hours: 60 Credits: 4

Course objectives:

- To know the fundamental knowledge of normed linear spaces.
- To study Banach spaces, inner product spaces and Hilbert spaces.
- To know important theorems of Functional analysis and their applications.

Course outcomes:

Student will be able to

- Understand normed linear spaces, Banach spaces, inner product spaces and Hilbert spaces.
- Explain the concept and applications of Functional analysis.
- Learn the concept of Functional analysis to develop mathematical skills.

Unit I: Banach spaces **25 h**

Normed linear spaces, Banach Spaces, Quotient spaces, Continuous linear Transformations, The Hahn-Banach theorem and its consequences, conjugate space and separability, Second conjugate space, The natural embedding of normed linear space and its second conjugate space, Weak* Topology on conjugate space, The open mapping theorem, Projection on Banach space, The closed graph theorem, the conjugate of an operator, The uniform boundedness theorem (Banach-Steinhauss theorem).

Unit II: Hilbert spaces **25 h**

Inner Product spaces, Hilbert space, Schwartz's inequality, Orthogonal complements, Projection theorem, Orthogonal sets, The Bessel's inequality, Fourier expansion and Parseval's equations, Gram-Schmidt orthogonalization process, Separable Hilbert space, The conjugate space, Riesz-Representation theorem, Operators and their adjoints on a Hilbert space, self adjoint operators, Normal and unitary operators.

Unit III: Spectral theory **10 h**

Finite dimensional spectral theory, Determinants and spectrum of an operator, The spectral theorem, Fixed points, Definition and examples, Banach contraction mapping theorem, Brouwer's fixed point theorem, Schauder's fixed point theorem

References

1. Simmons G. F. (1963), Introduction to Topology and Modern Analysis, McGraw Hill Book Company, New York (Chapter-9: Art 46 to 51; Chapter-10: Art 52 to 59; Chapter-11: Art 61 to 62; Appendix one)
2. Limaye B. V. 1996, Functional Analysis, New Age International (P), Ltd., Publishers; second editions. (chapter-6: Art 21 to 24; Appendix-A)
3. Bachman G and Narici L., Functional Analysis, Academic Press.
4. Berberian S. K., Functional Analysis and Operator theory, McMillan New York.
5. Kreyszig Erwin (1978), Introductory Functional Analysis with Applications, John Wiley and Sons.

6. Siddique A. H., Functional Analysis with applications, Wiley- Eastern Limited.
7. Chaudhary B. and Nanda Sudarshan (1989), Functional Analysis with applications, Wiley- Eastern.

M.Sc. (Mathematics): Semester-III

MT-302: Advanced numerical methods

Total Hours: 60 Credits: 4

Course objectives:

- To know the concept and applications of Numerical methods.
- To study basic and advanced concepts of solving linear equations.
- To know concept of Numerical methods to develop mathematical skills in solving various scientific problems.

Course outcomes:

Student will be able to

- Understand the concept of Queuing Numerical differentiation and Integration.
- Explain important principles and techniques of solving ODE by numerical methods.
- Learn important principles and techniques of solving PDE by numerical methods.

Unit I: System of Linear Equations 12 h

Methods of triangularization – Do little algorithm, Crout's method, inverse of a matrix by Crout's method, Gauss Jordan method for system of linear equations, Iterative methods of Jacobi and Gauss–Seidal, Relaxation method, convergence.

Unit II: Numerical Differentiation and Integration 12 h

Numerical differentiation using Forward, Backward, Central differences, Error analysis, higher derivatives of continuous and tabulated functions, maximum and minimum values of a function, difference tables and Richardson's extrapolation. Newton–Cotes Integration formulas, Trapezoidal rule, Simpson's $\frac{1}{3}$-rule, Error Analysis, Romberg integration, Numerical Double integration by trapezoidal and Simpson's rules.

Unit III: Numerical Solution of ODE (IVP and BVP) 18 h

Initial value problems, Numerical Solution of O.D.E using Picard, Taylor series, Modified Euler and Runge-Kutta fourth order methods, Predictor corrector methods. Linear BVP, shooting method, alternative method, Finite difference method of linear second order problems, derivative boundary condition, solution of tri-diagonal system.

Unit IV: Numerical Solution of PDE (BVP) 18 h

Introduction, deriving difference equations; numerical solution of elliptic equations, Leibnitz's iteration method for Laplace equation and Poisson's equation; Solution of Heat equation; Bendor-Schmidt method, Crank-Nicholson method; Hyperbolic equations, finite difference method and starting values.

References

1. Jain M. K., Iyengar S. R. K. and Jain R. K. (2014), Numerical methods for Scientific and Engineering Computation, New Age international Publishers.
2. Vedamurthy V. N. and Iyengar N. Ch. S. N. (1998), Numerical methods, Vikash Publishing House.
3. Balagurswamy E. (2017), Numerical Methods, Tata McGraw-Hill.
4. Sastry S. S., Introductory methods of Numerical Analysis (2012), Prentice Hall India, New Delhi.
5. Gerald C. and Wheatley O. (2003), Applied Numerical Analysis (Seventh Edition), Addison Publishing company.

M.Sc. (Mathematics): Semester-III

MT-303: Field theory

Total Hours: 60 Credits: 4

Course objectives:

- To know the concept and applications of Field theory.
- To study basic and advanced concepts of solving polynomial equations.
- To know concept of Galois theory and its applications.

Course outcomes:

Student will be able to

- Understand the concept of finite and algebraic extensions, splitting field, normal extensions, separable extensions.
- Explain the finite fields and roots of unity
- Learn the important theorems in Galois theory and their applications
- Understand the geometric constructions.

Unit I: Field extensions **15 h**

Finite extensions, Algebraic extensions, Simple extensions, Algebraic closure, Algebraically closed field, Splitting field, Normal extension, Conjugate elements.

Unit II: Separable extensions **15 h**

Separable polynomial, Separable extension, Purely inseparable elements, inseparable extensions, Perfect fields, Finite fields.

Unit III: Galois extension **15 h**

Galois extension, Galois group, Artin's theorem, Fundamental theorem of Galois theory, primitive n^{th} roots of unity, Cyclic extensions.

Unit IV: Solvability by radicals **15 h**

Simple radical extension, Radical extension, Galois group of a polynomial, Constructible number, Radical extension of type 2, Geometric constructions, Algebraically independent set, finitely generated extension, Transcendental basis, Transcendental extension, Purely transcendental extension.

References

1. Gopalakrishnan N. S.(2018), University Algebra, Wiley Eastern Limited, New Delhi. (Chapter-4: Art.-4.1 to 4.9).
2. Jacobson N. (2012), Basic Algebra-I (Second Edition), Hindustan Publishing Corporation.
3. Nagata M. (1977), Field Theory, Marcel-Dekker Inc.
4. Herstein I. N. (1975), Topics in Algebra, John Wiley and Sons, New Delhi.
5. Fraleigh J. B.(2003), A first Course in Abstract Algebra, Pearson.

M.Sc. (Mathematics): Semester-III

MT-304: Lattice theory

Total Hours: 60 Credits: 4

Course objectives:

- To know the concept and applications of Lattice Theory.
- To study relation between Graph Theory and Lattice Theory
- To know Lattice-ordered Groups and related concepts.

Course outcomes:

Student will be able to

- Understand the fundamental concepts of Lattice Theory and Lattice-ordered Groups.
- Explain the relation between Graph Theory and Lattice Theory.
- Learn the beauty of Lattice-ordered Groups and related concepts.

Unit I: Introductory Concepts of Lattices **20 h**

Introduction to Posets, Semi-lattice, Two definitions of lattices, Hasse Diagrams, Homomorphism, Isotone maps, Ideals, Congruence relations, Congruence lattice, Convex Lattice, The homomorphism theorem, Product of lattices, Complete lattices, Ideal lattice, Distributive and Modular Inequalities and Identities, Complements.

Unit II: Distributive Lattices **15 h**

Characterization theorem for modular and distributive lattice, Dedekind's characterization of modular lattice, Birkhoff's characterization of distributive lattices, Representation of distributive lattices, Stone's theorem, Nabchin theorem, Statement of Hashimoto's theorem.

Unit III: Elements of Lattice **09 h**

Distributive, Standard and Neutral elements.

Unit IV: Lattice-Ordered Groups **16 h**

Introduction to Lattice-ordered groups, Definition of the l-group, Calculations in l-group, Riesz Decomposition Theorem, Basic facts, Definition of Convex l-subgroup, Prime Subgroup, Polar.

References

1. Gratzer George (1978), General Lattice Theory, Birkhauser Verlag Basel. (Chapter-1: Art.-1, 2, 3, 4; Chapter-2: Art.-1; Chapter-3: Art.-2).
2. Kopytov V. M. and Medvedev N. Y. (1994), The Theory of Lattice-Ordered Groups, Springer-Science.(Chapter-1: Art.-1, 2, 3;Chapter-2:Art.-1, 2, 3; Chapter-3:Art.-1, 3, 4)
3. G. Birkhoff (1948), Lattice Theory, American Mathematical Society, New York.
4. Crawley Peter and Dilworth Robert P. (1973), Algebraic Theory of Lattices, Prentice-Hall.
5. Davey B. A. and Priestly H. A. (2002), Introduction to Lattices and Order, Cambridge University Press .
6. Jingjing Ma (2013), Lecture notes on Algebraic Structure of Lattice-Ordered rings, World scientific.

M.Sc. (Mathematics): Semester-III

MT-305(A): Combinatorics

Total Hours: 60 Credits: 4

Course objectives:

- To know the concept and applications of combination and permutation.
- To study extremization problems using generating function and recurrence relations
- To know relation between Graph Theory and Combinatorics.

Course outcomes:

Student will be able to

- Understand the fundamental concepts of combination and permutation.
- Explain the important theorems and their applications of inclusion-exclusion.
- Learn the problems using generating function and recurrence relations.

Unit I: Generating Counting Methods **15 h**

Counting principles, Arrangements and selections, Arrangements and selection with repetition, Distributions, Binomial identities.

Unit II: Generating functions **15 h**

Generating function models, Calculating coefficients of generating functions, Partitions, exponential generating functions, A summation method.

Unit III: Recurrence Relations **15 h**

Recurrence relation models, Divide and conquer relations, Solution of linear and inhomogeneous recurrence relation, Solution with generating functions.

Unit IV: Inclusion-exclusion **15 h**

Counting with Venn diagrams, Inclusion – exclusion formula, Restricted positions and Rook polynomials.

References

1. Tucker Alan (1995), Applied Combinatorics (Sixth Edition), John Wiley & sons, New York. (Chapter-5: Art-5.1-5.5; Chapter-6: Art-6.1-6.5; Chapter-7: Art-7.1-7.4; Chapter-8: Art-8.1-8.3).
2. Krishnamurthy V. (1989), Combinatorial Theory and Applications, East West Press, New Delhi.
3. Joshi K. D. (1989), Foundations of discrete mathematics, John Wiley & Sons.
4. Hall Marshall (1988), Combinatorial theory, John Wiley & Sons.

M.Sc. (Mathematics): Semester-III

MT-305(B): Fluid dynamics

Total Hours: 60 Credits: 4

Course objectives:

- To know the basic concept of Fluid Mechanics.
- To study concept of Fluid dynamics to develop mathematical skills
- To know concept and applications of Fluid Mechanics.

Course outcomes:

Student will be able to

- Understand the concept of Kinematics.
- Explain the important theorems and their applications concerned with Fluid Dynamics.
- Learn the concepts of Irrotational motion and Laminar flow.

Unit I: Introduction **10 h**

Basic concepts of Fluid Mechanics like pressure, density, external forces. Important types of flows and types of fluids. Some important formulae of vector calculus.

Unit II: Kinematics **10 h**

Two methods of study, velocity and acceleration of fluid particle, equation of continuity, boundary conditions, boundary surface, streamlines, path-lines and streak-lines. Irrotational flow, velocity potential, vorticity vector, angular velocity and rotational motion.

Unit III: Equations of motion **10 h**

Euler's equation of motion for inviscid fluids, impulsive forces and equation of motion, energy equation. One-dimensional inviscid incompressible flow and Bernoulli's theorem.

Unit IV: Motion in two dimensions **10 h**

Stream function, sources, sinks and doublets, Complex Potential, C-R equations in polarform, method and images, image with respect to a line and circle, Circle theorem, theorem of Blasius, Streaming Motion past a cylinder and sphere.

Unit V: Irrotational Motion **10 h**

General theory of irrotational motion, flow and circulation, Stoke's theorem, Green's theorem, Kelvin's theorem, Permanence of Irrotational motion, kinetic energy of infinite mass of liquid.

Unit VI: Laminar flow **10 h**

Real fluids, laminar flow for real fluids, N-S equations in Cartesian coordinates, some exact solutions of N-S equations, Coutte flow, Plane Poiseuille flow, Theory of lubrication, flow through circular pipe.

References

1. Rathy R. K. (1985), An Introduction to Fluid Dynamics, IBH.
2. Raisinghania M.D. (2018), Fluid Mechanics, Sultan Chand & Co. New Delhi.
3. Streetor Vector, Hand Book of Fluid Mechanics.
4. Chorlton F. (2004), A Textbook of Fluid Dynamics, CBS Publisher.

M.Sc. (Mathematics): Semester-III

MT-306(A): Problem course based on MT-301 and MT-302

Total Hours: 60 Credits: 4

Course objectives:

- To know concept of Functional Analysis and Numerical methods to develop mathematical skills.
- To solve problems on Functional Analysis.
- To solve problems on Numerical methods.

Course outcomes:

Student will be able to

- Understand the fundamental concepts of Functional Analysis and Numerical methods.
- Explain important techniques of solving problems on Banach spaces and Hilbert spaces.
- Explain important techniques of solving PDE by numerical methods.

M.Sc. (Mathematics): Semester-III

MT-306(B): Problem course based on MT-303 and MT-304

Total Hours: 60 Credits: 4

Course objectives:

- To know concept of Field theory and Lattice theory to develop mathematical skills.
- To solve problems on Field theory.
- To solve problems on Lattice theory
- To solve the MCQ type of questions.

Course outcomes:

Student will be able to

- Understand the fundamental concepts of Field theory, Lattice theory.
- Explain important techniques of solving problems on field extensions, Galois extensions, transcendental extensions.
- Explain important techniques of solving problems on Lattice theory and Lattice-Ordered Groups.

M.Sc. (Mathematics): Semester-IV

MT-401: Linear integral equations

Total Hours: 60 Credits: 4

Course objectives:

- To know concept and applications of Integral Equations.
- To study bilinear forms.
- To know the Integral Equations and related concepts.

Course outcomes:

Student will be able to

- Understand the concept of linear integral equations, Volterra Integro-Differential Equations, Volterra-Fredholm Integro-Differential Equations.
- Explain the origins of Integral Equations, Methods of solutions to Linear integral equations.
- Learn the fundamental properties of eigen values and eigen functions for symmetric kernels.

Unit I: Introductory Concepts of Integral Equations 10 h

Types of Integral equations, Types of linear integral equations: First kind, Second kind, Third kind, Homogeneous, Non-homogeneous, Types of kernels: Symmetric kernel, Separable kernel or Degenerate kernel, Iterated kernel, Resolvent kernel or Reciprocal kernel, Classification of Integral Equations: Fredholm integral equation, Volterra integral equation, Volterra-Fredholm integral equation, Singular integral equation, Definition and Classification of Integro-Differential Equations: Fredholm Integro-Differential Equations, Volterra Integro-Differential Equations, Volterra-Fredholm Integro-Differential Equations, Eigen value and Eigen function.

Unit II: Origins of Integral Equations **12 h**

Leibnitz Rule for Differentiation of Integrals, Reducing Multiple Integrals to Single Integrals, Converting IVP to Volterra Integral Equation, Converting Volterra Integral Equation to IVP, Converting BVP to Fredholm Integral Equation, Converting Fredholm Integral Equation to BVP, Solution of an Integral Equation, Conversion to a Volterra equation of the first kind to second kind.

Unit III: Methods of solutions to Linear integral equations **18 h**

Adomian decomposition, Modified Decomposition, Successive Approximations, Neumann Series, Successive Substitution, The Laplace Transform Methods, The Direct Computation Method, Resolvent kernel of Fredholm equations and its properties.

Unit IV: Symmetric Kernels **20 h**

Fundamental properties of Eigen values and Eigen functions for symmetric kernels, Expansion in Eigen functions and Bilinear form, Hilbert Schmidt Theorem and its consequences, Solution of symmetric integral equations.

References

1. Wazwaz A. M. (2011), Linear and Nonlinear Integral Equations-Methods and Applications, Springer. (Chapter-1: Art-1.3-1.5, Chapter-2: Art-2.1-2.7, Chapter-3: Art-3.1, 3.2(3.2.1-3.2.2, 3.2.5-3.2.6), 3.3(3.3.2-3.3.3), Chapter-4: Art-4.1, 4.2(4.2.1-4.2.2, 4.2.5-4.2.6), 4.3, Chapter-5: Art-5.1, 5.2(5.2.1, 5.2.3))
2. Kanwal R. P. (1971), Linear Integral Equation-Theory and Technique, Academic Press. (Chapter-7: Art-7.1-7.5)
3. Jerri A. J. (1999), Introduction to Integral Equations with Applications, Wiley-Interscience.
4. Krasnov M L, Kiselev A I, Makarenko G I and Yankovsky George (1971), Problems and exercises in Integral equations, Mir Publishers.
5. Cochran J. A. (1972), The Analysis of Linear Integral Equations, McGraw Hill Pub.
6. Green C. D. (1969), Integral Equation Methods, Thomas Nelson and sons.

M.Sc. (Mathematics): Semester-IV

MT-402: Operations research

Total Hours: 60 Credits: 4

Course objectives:

- To know concept and applications of Operations Research.
- To study operations Research to develop mathematical skills in business mathematics.
- To know the basic concepts of Network diagrams.

Course outcomes:

Student will be able to

- Understand the concept of Network diagrams and Queuing theory.
- Explain the important principles and techniques of decision theory and replacement theory.
- Learn the principles of inventory control and non-linear programming.

Unit I: PERT AND CPM 16 h

Introduction, Phases of project management, Network diagrams, Fulkerson's rule, slack, forward pass, backward pass, critical path, project duration, various floats, tabular form, differences between PERT and CPM, Project cost and crashing the Network.

Unit II: Queuing Models 12 h

Introduction, application of Queuing models, characteristics, arrival and service distribution, Kendall's notation for Queuing models, Single channel queuing theory, M/M/1 model and generalization, M/M/1: SIRO/model, M/M/1:FCFS/N/Finite queue length model, M/M/1:FCFS/n/N Limited source model, M/M/C:FCFS// Multi channel queuing theory model.

Unit III: Decision theory 10 h

Steps involved in Decision theory, decision making under uncertainty, Minimax, Maximin, Maximax, Hurwitz and Laplace criteria. Decision making under risk, Expected monetary value and Expected opportunity loss criteria and EVPI, Decision trees.

Unit IV: Replacement Models 08 h

Introduction, Replacement of Items that deteriorate with time with no changes in money value, with change in value of money, replacement of items that fail suddenly, individual replacement policy, group replacement policy and staffing problems.

Unit V: Inventory Models 08 h

Necessity and maintenance of Inventory, inventory costs, inventory control problems, inventory models with deterministic demand, with probabilistic demand, with price breaks, multi-item deterministic models, forecasting of demand, forecasting methods, seasonal demand, when to order, safety stock and how much to order.

Unit VI: Simulation 06 h

Introduction, when to use simulation, advantages and limitations of simulation techniques, Monte Carlo method, generation of random numbers, time flow mechanism, simulation languages.

References

1. Kapoor V. K. (2013), Quantitative Techniques for Management, Sultan Chand & Co. New Delhi.
2. Gupta P. K. and Hira D. S. (1992), Operations Research, Sultan Chand & Co., New Delhi.
3. Taha H. A. (2010), Operations Research: An introduction, Macmillan publishing Co.
4. Vohra N. D. (2018), Quantitative techniques in management, Tata Mc-Graw Hill.

M.Sc. (Mathematics): Semester-IV
MT-403: Commutative algebra

Total Hours: 60 Credits: 4

Course objectives:

- To know concept of sequence of modules and R-module homomorphisms, Tensor products.
- To study ring extensions.
- To know the concepts of integral extensions and valuation domain.

Course outcomes:

Student will be able to

- Understand the concept of exact sequences, projective and flat modules.
- Explain the concepts of Noetherian modules and primary decomposition theorem.
- Learn the Valuation rings and Discrete valuation rings.

Unit I: Projective Modules **15 h**

Exact sequences, Projective modules, Finitely generated modules, Shanuel's lemma, Tensor product, Tensor product w. r. t. exact sequences, flat modules, Faithfully flat modules.

Unit II: Local rings **10 h**

Local rings, Nakayama lemma, multiplicatively closed set, Localisation, Localisation and exact sequence, localisation and tensor product.

Unit III: Chain conditions in modules **10 h**

Noetherian modules, Primary submodules, Primary decomposition, Artinian modules, Structure theorem of Artinian rings.

Unit IV: Integral extensions **15 h**

Integral elements, Integral closure, Integral extensions, Going up theorem, Integrally closed domain, Going down theorem.

Unit V: Valuation rings **10 h**

Valuation rings, Ordered group, valuation on a field, Discrete valuation rings.

References

1. Gopalakrishnan N. S.(2016), Commutative Algebra, Universities Press (India) Pvt. Ltd. (Chapter- I: Art.-1.2 to 1.4, Chapter-II: Art.- 2.2 to 2.3, Chapter-III: Art.- 3.1 to 3.3, Chapter-IV: Art.-4.1 to 4.3, Chapter-V: Art- 5.1 to 5.2).
2. Atiyah M. F. and Donald Mac (2007), Introduction to Commutative Algebra, Sarat Book House.
3. Eisenbud David (1995), Commutative Algebra with a view toward Algebraic Geometry, Springer Verlag, New York.
4. Jacobson N. (1980), Basic Algebra Vol.-I & II, Hindustan Publishing Corporation (India).
5. Zarski O. and Samuel P. (1975), Commutative Algebra, Springer.
6. Rowen L. (1988), Ring theory Vol.-I & II, Academic Press.

M.Sc. (Mathematics): Semester-IV
MT-404: Advanced ring theory

Total Hours: 60 Credits: 4

Course objectives:

- To know concept of ideal theory in commutative rings.
- To study radical theory.
- To know the concepts of direct sum of rings and primary decomposition theorem.

Course outcomes:

Student will be able to

- Understand the concept of maximal ideals, prime ideals, nil radical of an ideal, semiprime ideals and primary ideals.
- Explain the concepts of Jacobson radical of a ring, Prime radical of a ring, Quasi-regular element, J-radical and J-semisimple ring.
- Learn the Prime avoidance theorem, Cohen's theorem and Krull intersection theorem.

Unit I: Ideal Theory **15 h**

Basic concepts of maximal ideals, prime ideals and nil radical of an ideal, semiprime ideals, primary ideals, Prime avoidance theorem.

Unit II: Certain Radicals of a Ring **15 h**

Jacobson radical of a ring, Semisimple ring, Prime radical of a ring, Quasi-regular element, J-radical, J-semisimple ring, Regular ring.

Unit III: Direct sum of rings **15 h**

Direct sum of rings, Subdirectly reducible and irreducible rings.

Unit IV: Primary decomposition in rings **15 h**

Introduction of irreducible ideals, irredundant primary representation, Cohen's theorem, Krull intersection theorem.

References

1. Burton D. M. (1970), A first course in ring and ideals, Addison-Wisley Publishing Company Inc. (Chapter-V: Art.-5.1 to 5.16, Chapter-VIII: Art.- 8.1 to 8.21, Chapter-IX: Art.-9.4 to 9.6, Chapter-X: Art- 10.1 to 10.6, Chapter-XII: Art.-12.1 to 12.11).
2. Jacobson N. (1980), Basic Algebra Vol.-I & II, Hindustan Publishing Corporation (India).
3. Dummit D. S. and Foote R. M. (2008), Abstract Algebra, Wiley student Edition, Wiley India Pvt. Ltd.

M.Sc. (Mathematics): Semester-IV
MT-405(A): Graph theory

Total Hours: 60 Credits: 4

Course objectives:

- To know the concept and applications of Graph theory.
- To study basic concepts of Graphs, trees and connectivity, Eulerian and Hamiltonian graphs.
- To know the matching, coloring of graphs and Cayley graphs.

Course outcomes:

Student will be able to

- Understand the algorithms: Kruskal’s Algorithm, Prim’s Algorithm, Breadth First Search (BFS) algorithm, Backtracing algorithm, Dijkstra’s Algorithm, Hungarian algorithm.
- Explain the well known theorems: Cayley’s Theorem, Dirac theorem, Bondy and Chavatal theorem, Travelling salesman problem.
- Learn the Planar graphs and Coloring of graphs.

Unit I: Graphs **10 h**

Definition and examples, graphs as models, subgraphs, Operations on graphs, Matrix representation of graphs, walks, Trails, Paths and Cycles, Connectedness and connectedness algorithm.

Unit II: Trees and Connectivity **12 h**

Definition and simple properties of a tree, Bridges, Spanning Trees, Cayley’s Theorem, Kruskal’s Algorithm, Prim’s Algorithm, Shortest path problems, The Breadth First Search (BFS) algorithm, The Backtracing algorithm, Dijkstra’s Algorithm, Cut vertices, Connectivity.

Unit III: Eulerian and Hamiltonian graphs **08 h**

Eulerian trails, Eulerian and semi Eulerian graphs, Fleury’s algorithm, The Chinese Postman Problem, Hamiltonian graphs, Dirac theorem, Closure of a graph, Bondy and Chavatal theorem, Travelling salesman problem.

Unit IV: Matching **12 h**

Matching and augmenting paths, Berge theorem, The Hall’s marriage problem, the personnel assignment problem and matching algorithm for bipartite graphs, The Hungarian algorithm.

Unit V: Planar graphs and Coloring of graphs **10 h**

Plane and Planar graphs, Euler’s Formula, Vertex coloring, Critical graphs, Cliques and edge coloring of graphs.

Unit VI: Cayley graphs **08h**

Definition of Cayley graph, Groups and graphs, Symmetry and regularity of graphs.

References

1. Clark John and Holton Derek Allan (1991), A First Look At Graph Theory, World Scientific.
2. Elena Konstantinova (2012), Lecture notes on some problems on Cayley graphs, Koper.
3. Bhave N. S. and T. T. Raghunathan (1990), Elements of Graph Theory, Goal Publications.
4. Harary F. (1969), Graph Theory, Addison-Wesley Publishing Company.
5. Parthsarathi K. R. (1994), Basic Graph Theory, Tata McGraw-Hill, New York.

M.Sc. (Mathematics): Semester-IV

MT-405(B): Algebraic topology

Total Hours: 60 Credits: 4

Course objectives:

- To know the concept of Geometric complexes and simplicial homology.
- To study simplicial approximations.
- To know the homotopic paths and fundamental group.

Course outcomes:

Student will be able to

- Understand the fundamental concepts and methods in algebraic topology.
- Explain the well known theorems: The Euler-Poincare theorem, Euler's theorem, Brouwer's fixed point theorem.
- Learn the relation between first homology group and fundamental group.

Unit I: Geometric Complexes and Polyhedra **10 h**

Geometric complexes, polyhedron, orientation of Geometric complexes.

Unit II: Simplicial Homology Groups **15 h**

Chains, Cycles, Boundaries, Homology groups, Examples and structure of homology groups, The Euler-Poincare theorem, Euler's theorem, Pseudo-manifolds, Fundamental group of S^n.

Unit III: Simplicial Approximation **15 h**

Simplicial approximation, Induced homomorphism on the homology groups, The Brouwer's fixed point theorem.

Unit IV: The Fundamental Group **20h**

Homotopic paths and Fundamental groups, Covering homotopy property for S^1, Examples of fundamental groups, Relation between first homology group and fundamental group.

References

1. Croom F. H. (1978), Basic Concepts of Algebraic Topology, Springer under graduate text. (Chapter-I: Art- 1.1 to 1.4, Chapter-II: Art-2.1 to 2.5, Chapter-III: Art-3.1 to 3.4, and Chapter-IV: Art-4.1 to 4.4.)
2. Deo Satya (2003), Algebraic Topology-A primer, Hindustan Book Agency.
3. Singer I. M. and Thorpe J. A. (1976), Lecture Notes on Elementary Topology and Differential Geometry, Springer Verlag, New York.
4. Spanier E. H. (1994), Algebraic Topology, Third Edition, Springer Verlag New York Inc.

M.Sc. (Mathematics): Semester-IV

MT-406(A): Problem course based on MT-401 and MT-402

Total Hours: 60 Credits: 4

Course objectives:

- To know concept of Linear Integral Equations and Operations Research to develop mathematical skills.
- To solve problems on Linear Integral Equations.
- To solve problems on Operations Research.

Course outcomes:

Student will be able to

- Understand the fundamental concepts of Linear Integral Equations and Operations Research.
- Explain important techniques of solving problems on linear integral equations, Volterra Integro-Differential Equations, Volterra-Fredholm Integro-Differential Equations, symmetric kernels.
- Explain important techniques of solving problems on Network diagrams, Queuing theory, simulation.

M.Sc. (Mathematics): Semester-IV

MT-406(B): Problem course based on MT-403 and MT-404

Total Hours: 60 Credits: 4

Course objectives:

- To know concept of Commutative algebra and Advanced Ring Theory to develop mathematical skills.
- To solve problems on Commutative algebra.
- To solve problems on Advanced Ring Theory
- To solve the MCQ type of questions.

Course outcomes:

Student will be able to

- Understand the fundamental concepts of ring theory and module theory.
- Explain important techniques of solving problems on modules, local rings, integral extensions, valuation rings.
- Explain important techniques of solving problems on Ideal theory, radical theory, direct sum of rings.

Skills imparted:

The curriculum is designed to inculcate basic principles of mathematical methods and analysis to apply in various fields of scientific research. The curriculum contains a wide variety of mathematical topics like topology, linear algebra, differential equations, numerical analysis, transformations, operations research, fluid mechanics, functional analysis and mathematical methods. Further the following skills are developed on successful completion:

- critical thinking
- problem solving
- analytical thinking
- quantitative reasoning
- ability to manipulate precise and intricate ideas
- construct logical arguments and expose illogical arguments
- time management
- teamwork
- independence

Job opportunity:

The designed curriculum offers job opportunities like:

- mathematics teacher
- Scientist
- Programmer
- Software professional
- Banker
- Accountant.
- Actuary
- Data analyst
- Engineer
- Investment manager
- Research leading to Ph. D. degree
- Self entrepreneurship