Rayat Shikshan Sanstha's

Sadguru Gadage Maharaj College,Karad

(An Autonomous College)

DEPARTMENT OF MATHEMATICS

NEP-2020 with Multiple Entry and Multiple Exit Option

Syllabus For

M.Sc. Mathematics Part-II

Semester III and IV

(Syllabus to be implemented from the Academic Year 2024-25)

NEP-2020 with Multiple Entry and Multiple Exit Option
M.Sc. (Mathematics) Programme Structure

M.Sc. (Mathematics) Part–II (Level-6.0)

Year	Level	Sem.	Major		RM	OJT / FP	RP	Cum. Cr.	Degree
			Mandatory	Electives					
I	6.0	Sem I	3*4+2	4	4	--	--	22	PG Diploma in Mathematics (after 3Yr UG Degree)
		Sem II	3*4+2	4	--	4	--	22	
Cum. Cr. For PG Diploma in Mathematics			28	8	4	4	--	44	
Exit option: PG Diploma in Mathematics (44 Credits) after Three Year UG Degree									
II	6.5	Sem III	3*4+2	4	--	--	4	22	MSc Mathematics Degree After 3 Year UG Or MSc Mathematics Degree after 4 Year UG
		Sem IV	3*4	4	--	--	6	22	
Cum. Cr. for 1 Year MSc Mathematics Degree			26	8	--	--	10	44	
Cum. Cr. for 2 Year MSc Mathematics Degree			54	16	4	4	10	88	
2 Years-4 Sem. MSc Mathematics Degree (88 credits) after Three Year UG Degree **or** 1 Year-2 Sem MSc Mathematics Degree (44 credits) after Four Year UG Degree									

Abbreviations: Yr.: Year; Sem.: Semester; OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; RP: Research Project; Cum. Cr. Cumulative Credits:

M.Sc. (Mathematics) Part–I (Level-6.0)

Semester	Mandatory Major 4 credits	Mandatory Major 2 credits	Mandatory Elective (any one) 4 credits	Mandatory RMand OJT/FP 4 credits
I	1) Linear Algebra 2) Real Analysis 3) Ordinary Differential Equations	Numerical Analysis-I	1) Differential Geometry 2) Integral Transforms 3) Basics of Python	Research Methodology
II	1) Complex Analysis 2) Topology 3) Advanced Calculus	Numerical Analysis - II	1) Combinatorics 2) Difference Equations 3) Algebraic Automata Theory	On job Training/ Field project

M.Sc. (Mathematics) Part–II (Level-6.5)

Semester	Mandatory Major 4 credits	Mandatory Major 2 credits	Mandatory Elective (any one) 4 credits	Mandatory RM and OJT/FP
III	1) Functional Analysis 2) Algebra 3) Classical Mechanics	Advanced Discrete Mathematics	1) Lattice Theory-I 2) Fuzzy Mathematics – I 3) Algebraic Number Theory	Research Project(4 credits)
IV	1) Field Theory 2) Integral Equations 3) Partial Differential Equations	---	1) Number Theory 2) Fuzzy Mathematics-II 3) Lattice Theory-I	Research Project (6 credits)

M. Sc. Mathematics (Part II) (Level-6.0)
(Semester III)(NEP-2020)
(Introduced from Academic Year 2024-25)

Title of Course: Functional Analysis
Subject Code: MJ-MMT23-301
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) The Study of the main properties of bounded operators between Banach and Hilbert spaces.
2) The basic result associated to different types of converges in normed spaces.
3) Define and thoroughly explain Banach and Hilbert spaces and self-adjoint operators
4) Identify and independently use contractions of Banach spaces.

Unit-I

Normed linear spaces, Banach spaces, Quotient spaces, Continuous linear transformations, Equivalent norms, Finite dimensional normed spaces and properties, Conjugate space and separability, The Hahn-Banach theorem and its consequences. **(15 Lectures)**

Unit-II

Second conjugate space, the natural embedding of the normed linear space in its second conjugate space, Reflexivity of normed spaces, Weak * topology on the conjugate space. The open mapping theorem, Projection on Banach space, the closed graph theorem, the conjugate of an operator, the uniform boundedness principle. **(15 Lectures)**

Unit-III

Hilbert spaces: examples and elementary properties, Orthogonal complements, The projection theorem, Orthogonal sets, The Bessel's inequality, Fourier expansion and Perseval's equation, separable Hilbert spaces, The conjugate of Hilbert space, Riesz's theorem, The adjoint of an operator. **(15 Lectures)**

Unit-IV

Self-adjoint operators, Normal and Unitary operators, Projections, Eigen values and eigenvectors of an operator on a Hilbert space, The determinants and spectrum of an operator, The spectral theorem on a finite dimensional Hilbert space. **(15 Lectures)**

Recommended Book(s):

1. G. F. Simmons: Introduction to Topology and Modern Analysis, Tata McGraw Hill, 1963.

Reference Books:

1. Erwin Kreyszig: Introductory Functional Analysis with Applications, John Wiley and Sons, 1978
2. G. Bachman and L. Narici: Functional Analysis, Academic Press, 1972.
3. A. E. Taylor: Introduction to Functional analysis, John Wiley and sons,1958.
4. J. B. Convey, A course in Functional Analysis, Springer-Verlag, 1985. 5. B. V. Limaye: Functioned Analysis, New age international, 1996

Title of Course: Algebra
Subject Code: MJ-MMT23-302
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) understand basic notions in Linear Algebra and use the results in developing advancedmathematics.
2) study the properties of Vector Spaces, Linear Transformations, Algebra of LinearTransformations and Inner product space in some details.
3) construct Canonical forms and Bilinear forms.
4) apply knowledge of Vector space, Linear Transformations, Canonical Forms and BilinearTransformations.

Unit-I

Simple groups, simplicity of A_n (n>5), commutator subgroups, normal subgroup and subnormal series, Jordan-Holder theorem, solvable groups, isomorphism theorems, Zassenhaus Lemma, Schreier refinement theorem. **(15 Lectures)**

Unit-II

Group action on a set, isometry subgroups, Burnside theorem, Syllow's theorems, p-subgroups, class equation and applications**.** **(15 Lectures)**

Unit-III

Rings of polynomials, factorization of polynomials over fields, irreducible polynomials, Eisenstein criterion, ideals in F[x], unique factorization domain, principle ideal domain, Gauss lemma, Euclidean Domain **(15 Lectures)**

Unit-IV

Modules, sub-modules, quotient modules, homomorphism and isomorphism theorems, fundamental theorem for modules**.** **(15 Lectures)**

Recommended Book(s):

1. Herstein I. N.: Topics in Algebra, 2nd Edition, Willey Eastern Limited.
2. Hoffman, Kenneth and Kunze R: Linear Algebra, Prentice Hill of India Private Limited.,1984.

Reference Books:

1. A. R. Rao and P. Bhimashankaran, Linear Algebra, Hidustan Book Agency.
2. Surjit Singh, Linear Algebra, Vikas publishing House (1997).
3. Gilbert Strang: Introduction to Linear Algebra, Wellesley-Cambridge Press

Title of Course: Classical Mechanics
Subject Code: MJ-MMT23-303
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) discuss the motion of system of particles using Lagrangian and Hamiltonian approach
2) apply D'Alembert's Principle on Lagrange's equation.
3) solve extremization problems using variational calculus.
4) analyze Routh's procedure.

Unit-I

Mechanics of a particle, Mechanics of a system of particles, Conservation theorems, Conservative force with examples, Constraints, Generalized co-ordinates, D'Alembert's Principle, Lagrange's equations of motion , The forms of Lagrange's equation for non-conservative system and partially conservative and partially non-conservative system, Lagrangian for charged particle in electromagnetic field, Kinetic energy as a homogeneous function of generalized velocities, Non-conservation of total energy due to the existence of non-conservative forces, Cyclic co-ordinates and generalized momentum, conservation theorems, motion of a particle under central force and first integral **(15 Lectures)**

Unit-II

Functionals , Basic lemma in calculus of variations, Euler-Lagrange's equations, First integrals of Euler-Lagrange's equations, the case of several dependent variables Undetermined end conditions, Geodesics in a plane and space, the minimum surface of revolution, The problem of Brachistochrone, Isoperimetric problems, Problem of maximum enclosed area, Shape of a hanging rope. Hamilton's principle for conservative and non-conservative systems, Derivation of Hamilton's principle from D'Alembert's principle, Lagrange's equations of motion for conservative and non-conservative systems from Hamilton's principle, Lagrange's equations of motion for non-conservative systems (method of Lagrange's undetermined multipliers). **(15 Lectures)**

Unit-III

Hamiltonian function, Hamiltonian Canonical equations of motion, Derivation of Hamilton's equations from variational principle, Physical significance of Hamiltonian, The principle of least action, Jacobi's form of the least action principle, Cyclic co-ordinates and Routh's procedure, Orthogonal transformations, Properties of transformation matrix, Infinitesimal rotations **(15 Lectures)**

Unit-IV

The Kinematics of rigid body motion: The independent co-ordinates of rigid body, The Eulerian angles, Euler's theorem on motion of rigid body, Angular momentum and kinetic energy of a rigid body with one point fixed, The inertia tensor and moment of inertia, Euler's equations of motion, Caley- Klein parameters, Matrix of transformation in Caley Klein parameters, Relations between Eulerian angles and Caley-Klein parameters**.**

(15 Lectures)

Recommended Book(s):

1. Goldstein, H. Classical Mechanics. (1980), Narosa Publishing House, New Delhi.Gupta, A. S. Calculus of Variations with Applications (1997), Prentice Hall of India.
2. Weinstock: Calculus of Variations with Applications to Physics and Engineering (International Series in Pure and Applied Mathematics). (1952), Mc Graw Hill Book Company, New York.

Reference Books:

1. Whittaker, E. T. A treatise on the Analytical Dynamics of particles and rigid bodies. (1965), Cambridge University Press.
2. Gupta, A. S. Calculus of Variations with Applications (1997), Prentice Hall of India.
3. Gelfand, I. M. and Fomin, S. V. Calculus of Variations (1963), Prentice Hall of India.
4. Rana, N.C. and Joag, P. S. Classical Mechanics. (1991) Tata McGraw Hill, New Delhi.

Title of Course: Advanced Discrete Mathematics
Subject Code: MJ-MMT23-304
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) gain advanced knowledge of Advanced Discrete Mathematics.
2) engage with unfamiliar problems and identify relevant solution strategies.
3) able to use Fleury's algorithm
4) understand the properties of tree

Unit-I

Graph: Definition, examples, isomorphism, simple graph, bipartite graph, complete bipartite graph, vertex degrees, regular graph, sub-graphs, complement of a graph, self-complementary graph, paths and cycles in a graph, the matrix representation of a graph.

(15 Lectures)

Unit-II

Fusion, definition and simple properties of a tree, bridges, spanning trees, cut vertices, Euler tours and Hamiltonian cycles, Fleury's Algorithm, Hamiltonian graphs, plane and planar graphs. **(15 Lectures)**

Recommended Book(s):

1. John Clark and Derek Holton, A first look at Graph Theory, Allied Publishers Ltd., 1991.
2. C.L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics, Tata McGraw Hill Pvt Ltd, 1985. 3. G. Gratzer, General Lattice Theory, Birkhauser, 2002.
4. J. Eldon Whitesitt, Boolean Algebra and Its Applications, Addison-Wesley Publishing Company, Inc.,1961.

Reference Books:

1. Seymon Lipschutz and Mark Lipson, Discrete Mathematics (second edition) Tata Mc Graw Hill Publishing Company Ltd. New Delhi.
2. Richard A. Brualdi, Introductory Combinatorics, Pearson, 2004.
3. Garrett Birkhoff: Lattice Theory, American mathematical society, 1940.

Title of Course: Lattice Theory-I
Subject Code: GE-MMT23-305(A)
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) Acquire thorough knowledge of fundamental notions from lattice theory and properties of lattices
2) To learn Modular and Distributive lattice
3) To know Stone Algebra
4) To solve individually and creatively advanced problems of lattice theory and also problems connected with its applications to mathematics

Unit-I

Posets, Definition and examples of Posets, Two definitions of lattices and their equivalence, examples of lattices, Description of Lattices, some algebraic concepts, Duality principle, Special elements, Homomorphism, Isomorphism and isotone maps

(15 Lectures)

Unit-II

Distributive lattices – Properties and characterizations, Modular lattices – Properties and characterizations, Congruence relations, Boolean algebras – Properties and characterizations. **(15 Lectures)**

Unit-III

Ideals and filters in lattices, Lattice of all ideals I(L), Properties and characterizations of I(L), Stone's theorem and its consequences. **(15 Lectures)**

Unit-IV

Pseudo complemented lattices, S(L) and D(L) – special subsets of pseudo complemented lattices, Distributive pseudo complemented lattice, Stone lattices – properties and characterizations. **(15 Lectures)**

Recommended Book(s):

1. Recommended Books: 1) George Grätzer, General Lattice Theory, Birkhäuser Verlag (Second Edition).

Reference Books:

1. G. Birkhoff, Lattice Theory, Amer. Math. Soc. Coll. Publications, Third Edition1973.

Title of Course: Fuzzy Mathematics-I
Subject Code: GE-MMT23-305(B)
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) Decide the difference between crisp sets and fuzzy sets.
2) Make calculation on fuzzy set theory.
3) Make application on fuzzy logic membership function and fuzzy inference systems.
4) Evaluate the fuzzy statistical problems.

Unit-I

Fuzzy sets and crisp sets, Examples of fuzzy sets, Basic types and basic concepts, Standard operations, Cardinality, degree of subset hood, Level cuts. **(15 Lectures)**

Unit-II

Representation of Fuzzy sets, Properties of level cuts, Decomposition theorems, Extension principle, Direct and inverse image of a fuzzy set. Properties of direct and inverse images. **(15 Lectures)**

Unit-III

Operations on fuzzy sets, Types of operations, Fuzzy complement, Equilibrium and dual point, Increasing and decreasing generators, Fuzzy intersection: t-norms, Fuzzy union: t-conorms, Combination of operators, Aggregation operations. **(15 Lectures)**

Unit-IV

Fuzzy numbers, Characterization theorem, Linguistic variables, Arithmetic operations on Intervals, Arithmetic operations on fuzzy numbers, Lattice of fuzzy numbers, Fuzzy equations. **(15 Lectures)**

Recommended Book(s):

1. George J. Klir, Bo Yuan, Fuzzy sets and Fuzzy Logic. Theory and Applications, PHI.Ltd.2000

Reference Books:

1. M. Grabish, Sugeno, Murofushi Fuzzy Measures and Integrals theory and Applications, PHI,1999.
2. H.J.Zimmerermann, Fuzzy set Theory and its Applications, Kluwer, 1984.
3. M. Hanss, Applied Fuzzy Arithmetic, An Introduction with Engineering Aplications, Springer-Verlag Berlin Heidelberg 2005.
4. M. Ganesh, Introduction to Fuzzy sets & Fuzzy Logic, PHI Learning Private Limited, New Delhi 2006.

5. Timothy J. Ross, Fuzzy Logic with Engineering Applications, 3rd Edition, John Wiley and Sons, 2011.

Title of Course: Algebraic Number Theory
Subject Code: GE-MMT23-305(C)
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) Understand properties of number fields.
2) Student will learn about the arithmetic of algebraic number fields.
3) They will learn to prove theorem about integral bases, and about unique factorization in
4) Find the Relationship between factorization of number and of ideals.

Unit-I

Revision of rings, polynomial rings and fields, Field extensions, Symmetric polynomials, Modules, Free Abelian groups. **(15 Lectures)**

Unit-II

Algebraic Numbers, Algebraic number fields, Conjugates and Discriminants, Algebraic integers, Integral Bases, Norms and Traces, Ring of integers, Quadratic fields, Cyclotomic fields. **(15 Lectures)**

Unit-III

Factorization into irreducible, Noetherian rings, Dedekind rings, Examples of Non-Unique factorization into irreducible, Prime factorization, Euclidean Domains, Euclidean quadratic fields. **(15 Lectures)**

Unit-IV

Ideals, Prime factorization of ideals, Norm of an ideal, Nonunique factorization in cyclotomic fields, Two-squares theorem, Four-squares theorem, class groups and class numbers, Finiteness of the Class groups. **(15 Lectures)**

Recommended Book(s):

I. N. Stewartand D. O. Tall, Algebraic Number Theory and Fermat's Last Theorem, 2015, CRC press.

Reference Books:

1. Algebraic Number Theory: Mathematical Pamphlet, TIFR, Bombay.
2. N. Jacobson, Basic Algebra-I, Hindustan Publishing Corporation (India), Delhi (Unit-I)

3. Paulo Ribenboim, Classical Theory of Algebraic Numbers, Springer, New York (2001).
4. N. S. Gopalkrishnan, University Algebra, New Age International (P) Ltd. Publishers.
5. Ian Stewart, Galoi Theory, CRC press (2015).
6. Harry Pollard, The Theory of Algebraic Numbers, The Mathematical Association of America.

M. Sc. Mathematics (Part I) (Level-6.0)
(Semester IV)(NEP-2020)
(Introduced from Academic Year 2024-25)

Title of Course: Field Theory
Subject Code: MJ-MMT23-401
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) determine the basis and degree of a field over its subfield.
2) construct splitting field for the given polynomial over the given field.
3) make use of fundamental theorem of Galois theory and fundamental theorem of Algebra to solve problems in Algebra.
4) apply Galois theory to constructions with straight edge and compass.

Unit-I

Adjunction of roots, Algebraic extensions, algebraically closed fields. **(15 Lectures)**

Unit-II

Splitting fields, Normal extensions, Multiple roots, Finite fields, Separable extensions.

(15 Lectures)

Unit-III

Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of algebra, Roots of unity and cyclotomic polynomials, Cyclic extensions. **(15 Lectures)**

Unit-IV

Polynomials solvable by radicals, Symmetric functions, Ruler and compass constructions.

(15 Lectures)

Recommended Book(s):

1. Bhattacharya, Jain and Nagpaul, Basic Abstract Algebra, second edition, Cambridge University Press.

Reference Books:

1. 1. Joseph Rotman, Galois Theory,second edition, Springer.
2. Nathan Jacobson, Basic Algebra I, second edition, W. H. Freeman and company, New York
3. U. M. Swamy, A. V. S. N. Murthy, Algebra: Abstract and Modern, Pearson

Education, 2012

4. I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd.
5. John Fraleigh, A first course in Abstract Algebra (3rd edition) Narosa publishing house, New Delhi
6. I. T. Adamson, Introduction to Field Theory, second edition, Cambridge University Press,1982.
7. M. Artin, Algebra, PHI, 1996.
8. Ian Stewart, Galois Theory, CRC Publication.2.

Title of Course: Integral Equation
Subject Code: MJ-MMT23-402
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) classify the linear integral equations and demonstrate the techniques of converting the initial and boundary value problem to integral equations and vice versa.
2) develop the technique to solve the Fredholm integral equations with separable kernel
3) develop and demonstrate the technique of solving integral equation by Successive approximations, using Laplace and Fourier transforms.
4) to prove Hilbert Schmidt theorem and solve the integral equation by applying it

Unit-I

Classification of linear integral equations, Conversion of initial value problem to Volterra integral equation, Conversion of boundary value problem to Fredholm integral equation, Separable kernel, Fredholm integral equation with separable kernel, Fredholm alternative. Homogeneous Fredholm equations and eigenfunctions. **(15 Lectures)**

Unit-II

Solutions of Fredholm integral equations by: Successive approximations Method, Successive substitution Method, Adomian decomposition method, Modified decomposition method, Resolvent kernel of Fredholm equations and its properties, Solutions of Volterra integral equations: Successive approximations method, Neumann series, Successive substitution Method. **(15 Lectures)**

Unit-III

Solution of Volterra integral equations by Adomian decomposition method, and the modified decomposition method, Resolvent kernel of Volterra equations and its properties, Convolution type kernels, Applications of Laplace and Fourier transforms to solutions of Volterra integral equations, Symmetric Kernels: Fundamental properties of eigenvalues and eigenfunctions for symmetric kernels, expansion in eigenfunctions and bilinear form. **(15 Lectures)**

Unit-IV

Hilbert Schmidt Theorem and its consequences, Solution of symmetric integral equations, Operator method in the theory of integral equations, Solution of Volterra and Fredholm integrodifferential equations by Adomian decomposition method, Green's function: Definition, Construction of Green's function and its use in solving boundary value problems. **(15 Lectures)**

Recommended Book(s):

1. R. P. Kanwal, Linear Integral Equation: Theory and Technique, Academic Press, 1971.
2. Abdul-Majid Wazwaz, Linear and Nonlinear Integral Equations: Methods and Applications, Springer, 2011

Reference Books:

1. L. G. Chambers, Integral Equations- A Short Course, International Text Book Company, 1976.
2. M. A, Krasnov, et.al. Problems and exercises in Integral equations, Mir Publishers, 1971.
3. J. A. Cochran, The Analysis of Linear Integral Equations, Mc Graw Hill Publications, 1972.
3. C. D. Green, Integral Equation Methods, Thomas Nelson and sons, 1969.

Title of Course: Partial Differential Equation
Subject Code: MJ-MMT23-403
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) Determine the complete solution of Partial Differential Equations
2) Find the integral surface of a quasi-linear partial differential equations.
3) Explore the use of partial differential equation as models for processes wave Equation.
4) Student will identify the types of Partial differential equation and apply the method

Unit-I

The Laplace Transform, The Transforms of Some Typical Functions, Basic Operational Properties, the inverse Laplace Transform, Applications Involving Laplace Transforms, Evaluating Integrals, Solutions of ODEs, Solutions of PDEs. **(15 Lectures)**

Unit-II

Charpit's method, Jacobi method of solving partial differential equations, Cauchy Problem, Integral surfaces through a given curve for a linear partial differential equation, for a non-linear partial differential equation, Method of characteristics to find the integral surface of a quasi-linear partial differential equations and nonlinear first order partial differential equations.

(15 Lectures)

Unit-III

Second order Partial Differential Equations. Origin of Partial differential equation, wave equations, Heat equation. Classification of second order partial differential equation. Vibration of an infinite string (both ends are not fixed) Physical Meaning of the solution of the wave equation. Vibration of a semi-infinite string, Vibration of a string of finite length, Method of separation of variables, Uniqueness of solution of wave equation. Heat conduction Problems with finite rod and infinite rod, Cauchy problems. **(15 Lectures)**

Unit-IV

Families to equipotential surfaces, Laplace equation, Solution of Laplace equation, Laplace Equation in polar form, Laplace equation in spherical polar coordinates. Kelvin's inversion Theorem. Boundary Value Problems: Dirichlet's problems and Neumann problems. Maximum and Minimum principles, Stability theorem. Dirichlet Problems and Neumann problems for a circle, for a rectangle and for a upper half plane, Riemann's Method of solution of Linear Hyperbolic equations, Hartack's theorem. **(15 Lectures)**

Recommended Book(s):

1.T. Amaranth, An elementary course in Partial differential equations, Narosa publication, 1987.

Reference Books:

1. Fritz John, Partial Differential Equations 4thEdition, Springer Science & Business Media, 1991

2. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publication 2013.

Title of Course: Lattice Theory-II
Subject Code: GE-MMT23-404(A)
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) analyze Congruences and Ideals
2) check Modularity and semi modularity in given lattice
3) apply geometric closure operator
4) use Kurosh–Ore replacement property

Unit-I

Week projective and congruences, Distributive, Standard and Neutral Ideals, Structure theorems. **(15 Lectures)**

Unit-II

Modular lattices, Semi modular Lattices, Geometric lattices. **(15 Lectures)**

Unit-III

Partition of Lattices, Complemented modular Lattices Direct decompositions, Kurosh – Ore theorem, Ore's theorem, sub group lattices. **(15 Lectures)**

Unit-IV

Rank and covering Inequalities, Geometric closure operators, Semi-modular Lattices and selectors, consistent semi modular lattices. **(15 Lectures)**

Recommended Book(s):

1) Lattice Theory: George Gratzer, W. H. Freeman and company, SanFrancisco,1971.
2) Semi modular Lattices Theory and Applications: Manfred Stern, Cambridge University Press, 1999

Reference Books:

1)Lattice Theory: G. Birkhoff, Amer. Math. Soc. Coll. Publications, Third Edition 1973.

Title of Course: Fuzzy Mathematics-II
Subject Code: GE-MMT23-404(B)
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:

1) acquire the concept of fuzzy relations.
2) develop the skills of solving fuzzy relation equations.
3) construct approximate solutions of fuzzy relation equations.
4) solve problems in Engineering and medicine.

Unit-I

Projections and cylindrical extensions, binary fuzzy relations on single set, fuzzy equivalence relations, fuzzy compatibility relations, fuzzy ordering relations, fuzzy morphisms supi-composition and inf-wi composition. **(15 Lectures)**

Unit-II

Fuzzy relation equations, problem partitioning, solution methods, fuzzy relational equations based on sup-i and inf-wi compositions, approximate solutions. **(15 Lectures)**

Unit-III

Fuzzy propositions, fuzzy quantifiers, linguistic edges, inference from conditional fuzzy propositions, qualified and quantified propositions. **(15 Lectures)**

Unit-IV

Approximate reasoning: fuzzy expert systems, fuzzy implications, selection of fuzzy implications, multi-conditional approximate reasoning, the role of fuzzy relation equations, internal valued approximate reasoning. **(15 Lectures)**

Recommended Book(s):

1. George J Klir, BoYuan, Fuzzy Sets and Fuzzy Logic: Theory and applications, PHI. Ltd.(2000)

Reference Books:

1. M. Grabish, Sugeno, and Murofushi, Fuzzy Measures and Integrals: Theory and Applications PHI, 1999.
2. H. J. Zimmerermann, Fuzzy set: Theory and its Applications, Kluwer,1984.
3. M. Ganesh, Introduction to Fuzzy sets & Fuzzy Logic; PHIL earning Private Limited, New Delhi. 2011.
4. John Mordeson, Fuzzy Mathematics, Springer,2001.

Title of Course: Number Theory
Subject Code: GE-MMT23-404(C)
Total Credit: 04

Course Outcomes: Upon successful completion of this course, the student will be able to:
1) learn more advanced properties of primes and pseudo primes.
2) apply Mobius Inversion formula to number theoretic functions.
3) explore basic idea of cryptography
4) understand concept of primitive roots and index of an integer relative to a given primitive root.

Unit-I

Review of divisibility: The division algorithm, G.C.D., Euclidean algorithm, Diophantine equation ax + by = c. Primes and their distribution: Fundamental theorem of Arithmetic, The Goldbach Conjecture. **(15 Lectures)**

Unit-II

Congruences: Properties of Congruences, Linear congruences, Special divisibility tests. Fermat's theorem: Fermat's factorization method, Little theorem, Wilsons theorem. Number theoretic functions: The functions τ and σ. The Mobius Inversion formula, The greatest integer function. **(15 Lectures)**

Unit-III

Euler's Generalization of Fermat's theorem: Euler's phi function, Euler's theorem, properties of phi function, An application to Cryptography. Primitive roots: The order of an integer modulo n. **(15 Lectures)**

Unit-IV

Primitive roots for primes, composite numbers having primitive roots, The theory of Indices. The Quadratic reciprocity law: Eulerian criteria, the Legendre symbol and its properties, quadratic reciprocity, quadratic reciprocity with composite moduli.

(15 Lectures)

Recommended Book(s):

1. D.M.Burton : Elementary Number Theory, Seventh Ed.MacGraw Hill eucation(India)Edition 2012, Chennai.

Reference Books:

1. S.B.Malik :Baisc Number theory, Vikas publishing House.
2. George E.Andrews : Number Theory, Hindusthan Pub. Corp.(1972).
3. Niven, Zuckerman : An Introduction to Theory of Numbers. John Wiley & Sons.
4. S. G. Telang , Number Theory, Tata Mc.Graw-Hill Publishing Co., New Delhi.
5. M.B. Nathanson, Methods in Number Theory, Springer(2009).