Rajarshi Shahu Mahavidyalaya(Autonomous),Latur

Department of Mathematics

Year 2020-21

Syllabus for

M.Sc.-I (Mathematics)

CBCS Pattern

w.e.f. 2020-2021

(Autonomous)

BoS in Mathematics

1. **Introduction:**

M. A. / M. Sc. Mathematics program is of minimum 100 credits spread over four semesters. The program emphasizes both theory and applications of Mathematics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, a large number of elective courses, extensive computer training including standard software packages such as LATEX MATLAB,. The department has the academic autonomy and it has been utilized to add the new and need based elective courses. The independent project work is one of the important components of this program. The syllabus of the first year (two semesters) covers four core courses and one elective from three choices .The syllabus has been framed to have a good balance of theory, methods and applications of Mathematics. It is possible for the students to study basic courses from other disciplines such as economics, life sciences, computer science and mathematics in place of electives.

The courses for the PG Program are framed using time tested and internationally popular text books so that the courses are at par with the courses offered by any other reputed universities around the world.

In this program there are core courses and optional papers .The M.Sc program is so designed that those who is having B.Sc (General)/B.Sc (Honors) streams can study M.Sc Papers without any difficulties. The optional Papers are purely foundational courses for further research where as Core courses are purely NET/SET/GATE oriented.

The inclusion of Computer based courses has several advantages. The students offering these courses will be in demand in industry and shall get preference in teaching and research institute.

As learning Mathematics is doing Mathematics, to this end, some activities are prescribed to increase student's participation in learning. Duration of the degree program shall be four semesters distributed in a period of two academic years.

2. Title of the Course: M.Sc. (Mathematics)

3. Objectives of the Course:

Successful Mathematics students of this institute will gain lifelong skills, including following:

- To develop their mathematical knowledge and oral, written and practical skills in a way which encourages confidence and provides satisfaction and enjoyment.
- The development of their mathematical knowledge.
- Confidence by developing a feel for numbers, patterns and relationships.
- An ability to consider and solve problems and present and interpret results.
- Communication and reason using mathematical concepts.
- To develop an understanding of mathematical principles.
- To develop the abilities to reason logically, to classify, to generalize and to prove.
- To acquire a foundation appropriate to their further study of research fields in mathematics and of other disciplines.

4. Advantages of the Course:

Student will be getting highly motivated for higher studies in research fields of mathematics

5. Duration of the Course:	Two years
6. Eligibility of the Course:	**For M.Sc. I :**B.Sc. with Mathematics as principal Subject at degree level.
7. Strength of the Students:	30
8. Fees for Course:	As per UGC/University/College rules.
9. Period of the Course:	As per UGC/University/College rules
10. Admission / Selection procedure:	As per UGC/University/College rules
11. Teacher's qualifications:	As per UGC/University/College rules
12. Standard of Passing:	As per UGC/University/College rules
13. Nature of question paper with scheme of marking:	As per UGC/University/College rules
15**. List of book recommended**:	Included in syllabus
16. **List of Laboratory Equipments, Instruments, Measurements etc.:**	Matlab Software with one computer Lab
17. **Rules and regulations and ordinance if any:**	As per UGC/University/College rules
18. Medium of the language:	English
19. Structure of the Course:	Attached as Annexure 'A'
20. Allotment of workload (Theory/Practical):	Attached as Annexure 'A'

21. Staffing pattern:	As per UGC/University/College rules.
22. Intake capacity of students:	As per UGC/University/College rules
23. Paper duration:	Each theory paper is of 45Contact hours
24. To be introduced from:	**M. Sc. I from June 2020(Second Revision)**

Chairman Board of Studies
Mathematics

(Mr. M. S. Wavare)

List of BoS Members

(2019-2022)

1. Dr. D D Pawar (VC Nominee)

Director,
School of Mathematical Sciences
Swami Ramanand Teerth Marathwada University,
Nanded.

2. Dr. S D Kendre (Subject Expert)
   Department of Mathematics,
   SPPU,Pune
3. Dr. M T Gophane (Subject Expert)
   Department of Mathematics
   Shivaji University ,Kolhapur .
4. Dr. A A Yadav
   R S M , Latur
5. Prof .S M Shinde (Student Alumni)
   Govt.College of Engg., Karad Dist :Satara
6. Mr. S S Ranmal
   Sungrace Computers Pvt Ltd, Pune
7. Prof. N . S. Pimple
   R S M , Latur
8. Dr. S B Birajdar
   R S M , Latur
9. Mr. S D Malegaokar
   R S M , Latur
10. Miss A B Kale
    R S M , Latur
11. Mr. D M Ghuge
    R S M , Latur

Program Outcomes

Successful PG Mathematics students of this institute will gain lifelong skills, including following:

1. They can qualify CSIR-NET/SET/GATE
2. They will get tune with further studies of their area of interest
3. They can be good teacher in Mathematics
4. They can get placed in job of Scientific Computing /Data Analyst
5. They can become good citizen

Annexure 'A'

Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)

Department of Mathematics

M.Sc. I (CBCS) Semester I

Curriculum Structure with effect from June, 2020

Course Code	Paper Number	Title of the course with paper number	Hours/ Week	Marks (100)		Credits
				In Sem	End Sem	
P-ABA-164	I	Abstract Algebra	06	40	60	04
P-ADC-165	II	Advanced Calculus	06	40	60	04
P-ODE-166	III	Ordinary Differential Equations	06	40	60	04
P-COA-167	IV	Complex Analysis-I	06	40	60	04
Elective-I P-DIM-168(A) Or P-THP-168(B) P-COM-168(C)	V(A) V(B) V(C)	Choose any one Discrete Mathematics(A) or Theory of Probability(B) or Combinatorics (C)	06	40	60	04
P-LAB-169	Lab-I	Lab Work-I(Latex Typesetting)	04	40	60	04
P-SEM-170		Seminar	01	--	25	01
		Total Credits				25

Student Stay Hours: 35/Week

M.Sc. I (CBCS) Semester II

Curriculum Structure with effect from June, 2020

Course Code	Paper Number	Title of the course with paper number	Hours/ Week	Marks (100)		Credits
				In Sem	End Sem	
P-LIA-264	VI	Linear Algebra	06	40	60	04
P-MIT-265	VII	Measure and Integration Theory	06	40	60	04
P-TOP-266	VIII	Topology	06	40	60	04
P-PDE-267	IX	Partial Differential Equations	06	40	60	04
Elective-II P-COA-268 (A) P-OPR-268 (B) P-NUT-268 (C)	 X(A) X(B) X(C)	Choose-I Complex Analysis-II Or Operations Research Or Number Theory	06	40	60	04
P-LAB-269	Lab-II	Lab work (Writing and Presentation using LaTeX)	04	40	60	04
P-SEM-270		Seminar	01	---	25	01
		Total Credits				25

Student Stay Hours: 35/Week

M. Sc. – I [Mathematics] Semester I

Course Code: P-ABA-164

Paper-I

Abstract Algebra

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives :

- **To study basic group theory, Action on group**
- **To study Caley theorem**
- **To study Syllow's theorem**

Course Outcomes:

- **Students are able to learn Action mapping and fundamental theorems of homomorphism**
- **Students able to solve examples on direct product and Syllows theorem**
- **Relate abstract algebraic constructs to more familiar number sets and operations and see from where the constructs derive. Identify examples of specific constructs.**

Unit-I:

Groups, semi groups and groups, Homomorphism, Subgroups and cosets, Cyclic groups, Generators and relations, Normal subgroup and quotient group, Isomorphism theorems, Automorphism, Conjugacy and G-sets,

Unit-II:

Isomorphism theorems, Automorphism, Conjugacy and G-sets, Normal series, Solvable groups, Nilpotent groups.

Unit-III

Group Homomorphism, First Isomorphism Theorem, Fundamental Theorem of Finite Abelian Groups, Permutation Groups, Cyclic decomposition, Alternating group A_n,

Unit-IV

Structure of groups, Direct product, Finitely Generated Abelian Groups, Invariants of a finite abelian group, Sylow Theorems and its applications

Reference Books

1. **P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul**, "Basic Abstract Algebra", (Second Ed.), Cambridge Univ. Press (Indian Ed.1995).

2. **Joseph A. Gallian**, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa, 1999.

3. **I. S. Luthar and I. B. S. Passi**, "Algebra-Vol. 1: Groups", Narosa, New Delhi, 1996.

4. **V.K. Khanna, S.K. Bhambri**, "A Course in Abstract Algebra", Vikas Publicing House. (Second Edition)

5. **David Dummit and Richard Foote**, "Abstract Algebra", John Wiley and Sons.

M. Sc. – I [Mathematics] Semester I

Course Code: P-ADA-165

Paper-II

Advanced Calculus

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

- The concept of limit of sequences of functions and function of more variables.
- Power series, disc of convergence, radius of convergence and its applications.
- Derivatives and integrals of higher dimensional functions.

Course Outcomes:

Students will able to

- Analyze any type of sequence or series
- Check differentiability and find total derivative and directional derivatives
- Find line integral, surface integral mainly using fubini's theorem

Unit 1 : Sequences and series of functions: Pointwise convergence of sequences of functions, Examples of sequences of real valued functions, Definition of uniform convergence, Uniform convergence and continuity, Cauchy condition for uniform convergence, Uniform convergence and Riemann integration, Uniform convergence and differentiation, Equicontinuous family of functions.[1,2] 15 Lectures

Unit 2: Multivariable differential Calculus: The Directional derivatives, directional derivatives and continuity, total derivative, total derivatives expressed in terms of partial derivatives, The matrix of linear function, mean value theorem for differentiable functions, A sufficient condition for differentiability, sufficient condition for equality of mixed partial derivatives, Taylor's formula for functions from R^n to R.[2,1] 15 Lectures

Unit 3: Implicit functions: Functions of several variables, Linear transformations, Differentiation, Contraction principle, The inverse function theorem, The implicit function theorem and their applications.[1] 15 Lectures

Unit 4: Integral Calculus: Path and line integrals, Multiple integrals Double integral (Theorems without proof) Application to area and volume.(Theorems without proof)Greens theorem in the plane. Application of Green's Theorem. Necessary condition for a vector field to be gradient. Length of the curve. Change of variables, special cases of transformation formula. Surface integral, change of parametric representation. Other notations for surface integrals, Stoke's Theorem Curl and divergence of a Vector field. Gauss divergence Theorem. [3]

15 Lectures

Reference books :

1) Principles of mathematical Analysis, Walter Rudin, third Edition, McGraw Hill book company

2) Mathematical Analysis, Apostal, Second Edition, Narosa Publishing House.

3) Calculus Vol. II , Tom M. Apostol, Second EditionWiley India Pvt. Ltd

4) W.Fleming, Functions of several Variables,2nd Edition ,Springer Verlag, 1977. 2)J.R.Munkres, Analysis on Manifolds.

M. Sc. – I [Mathematics] Semester I

Course Code: P-ODE-166

Paper-III

Ordinary Differential Equations

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

- Learn to solve first-order differential equations.
- Learn to solve linear differential equations of higher-order.
- Learn to solve a second-order differential equation with constant coefficients.
- Learn to solve differential equations with variable coefficients
- Learn to check existence and uniqueness of solutions to first order differential equations

Course Outcomes:

Students that successfully complete this course will able to

1. Recognize definition and properties of initial value problems
2. Recognize definition and properties of linear dependence and independence, Wronskian, singular points, regular singular points, Lipschitz constant
3. Apply power series solution method , method of successive approximation
4. Recognize properties of Eular equation and Bessel equation, non – local existence of solutions.

Unit I Linear equations of first order, Initial Value Problem for second order equations:

Initial value problems, Solutions of the homogeneous equation.

Unit II Linear Equations with constant coefficients:

Linear dependence and independence, A formula for the Wronskian, The non-homogeneous equations of order two, The homogeneous equations of order *n*, Initial Value Problem for *n*th order equations, Equations with real constants, The non-homogeneous equations of order-*n*, A special method for solving the non-homogeneous equation, Algebra of constant coefficient operators.

Unit III Linear equations with variable coefficients:

Wronskian and linear independence, Reduction of order, Non-homogeneous equations, Legendre equation, Linear Equations with regular singular points: Euler equation, Second order equation with regular singular points, Exceptional cases, The Bessel equation, The Bessel equation (Continued).

Unit IV Existence and uniqueness of solutions to first order equations:

Separation of variables, Exact equations, Method of successive approximations, Lipchitz condition, Convergence of the successive approximations, Non local existence of solutions, Approximations to, and uniqueness of solutions, Equations with complex valued functions.

Reference Books

1.E. A. Codington, "An Introduction to Ordinary Differential Equations",(Prentice- Hall).

2.G. F. Simmons and S. G. Krantz, "Differential Equations", (Tata McGraw-Hill).

3.Daniel A. Murray, "Introductory Course in Differential Equation"**,** Universities Press.

M. Sc. – I [Mathematics] Semester I

Course Code: P-COA-167

Paper-IV

Complex Analysis-I

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- Complex Field, Algebra of complex numbers,
- Stereographic Projection, Transformation & Mapping Properties.
- Analyticity, Harmonic Functions, Maclaurin's and Taylor Series, Operations on Power series, Operations on Power series.
- Line Integrals, Cauchy's Theorems and its applications.

Course Outcomes:

On completion of this course successful students will be able to:

- Understand how complex numbers provide a satisfying extension of the real numbers
- Describe and parameterize curves and regions in two-dimensional space
- Appreciate how throwing problems into a more general context may enlighten one about a specific context (e.g. solving real integrals by doing complex integration; Taylor series of a complex variable illuminating the relationship between real function that seem unrelated -- e.g. exponentials and trig functions);
- Learn techniques of complex analysis that make practical problems easy (e.g. graphical rotation and scaling as an example of complex multiplication);
- Continue to develop proof techniques;
- Appreciate how mathematics is used in design (e.g. conformal mapping);
- know the condition(s) for a complex variable function to be analytic and/or harmonic

Unit I Complex Variables:

Complex Field, Modulus, Argument and Conjugate of complex numbers, Algebra of complex numbers, Rectangular and Polar representation of Complex numbers, Point sets in the plane, Sequences.

Unit II Basic Mappings:

Stereographic Projection, Linear Fractional , Transformation, Other Mappings, The Exponential Function, Mapping Properties, The Logarithmic Function, Complex Exponents.

Unit III Cauchy–Riemann Equation:

Analyticity, Harmonic Functions, Sequences of Functions, Uniform Convergence, Maclaurin and Taylor Series, Operations on Power series.

Unit IV Cauchy's Integration:

Curves , Parameterizations, Line Integrals, Cauchy's Theorems.

Reference Books

1. **S. Ponnusamy and Herb Silverman**, "Complex Variables with Applications", Birkhauser Publication.

2.Silverman Herb, "Complex Analysis",

3.**John B. Convey**, "Function of one complex variable", Narosa Pub.House , 1980.

4. **Lars V. Ahlofors**, "Complex Analysis", McGraw Hill Co.

6. **S. Ponnusamy**, " Foundations of Complex Analysis", Narosa Publishing House.

M. Sc. – I [Mathematics] Semester I

Course Code: P-DIM-168(A)(Elective -I)

Paper-V(A)

Discrete Mathematics

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives :

- **Basic algebraic system defined by lattices**
- **Finite and infinite graph**
- **Planer graph**
- **Matrix representation of graph**

Course Outcomes:

Students are able to

- **Study finite Boolean algebra**
- **Differentiate different types of graphs**
- **To find all spanning trees of graph**
- **To prepare matrix representation of every graph**

Unit I:

Lattices and Algebraic systems, Principle of duality, Basic properties of algebraic systems defined by lattices, Distributive and Complemented lattices, Boolean lattices and Boolean algebras, Uniqueness of finite Boolean algebras, Boolean functions and Boolean expressions, Propositional Calculus, Design and implementation of Digital Networks, Switching Circuits.

Unit II:

Definition and types of graphs, Applications of graphs, Finite and infinite graphs, Incidence and degree, Isolated vertex, Pendant vertex, Null graph, Brief history of graph theory, Isomorphism, Subgraphs, Walks, Paths and Circuits, Connected and Disconnected graphs, Euler graphs, More on Euler graphs, Operations on graphs, Hamiltonian paths and circuits,

Unit III:

The travelling salesman problem, Trees, Properties of trees, Pendant vertices in a tree, Distance and centre in a tree, Rooted and binary tree, On counting trees, Spanning trees, Fundamental circuits, Finding all spanning trees of a graph, Spanning trees in a weighted graph, Planar graph, Kurtatowski's two graphs, Different representations of a planar graph, Detection of planarity, Geometrical planarity, Thickness and crossings.

Unit IV:

Matrix representation of graphs, Incidence matrix, Sub matrices of A(G), Circuit matrix, Fundamental circuit matrix and its rank, An application to a switching network, Adjacency matrix, Directed graphs, Types, Digraphs and binary relations, Directed paths and Connectedness, Euler digraphs, Trees with directed edges, Fundamental circuits in digraphs.

Reference books:

1. **C L Liu**, "Elements of Discrete Mathematics", Tata McGraw-Hill, Publishing Company (Second Edition).
2. **Narsingh Deo**, "Graph theory with applications to engineering and computer science", Prentice –Hall of India Pvt. Ltd.
3. **J.P. Tremblay, R. Manohar**, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt.Ltd.
4. **Kenneth N Rosen**, "Discrete Mathematics and its applications with combinatorics and graph theory", Tata-McGraw Hill Education Pvt.Ltd.
4. **Sanjeev Kumar, Sanjay Chaudhary**, "Applied Discrete Mathematics Theory and applications", Ram Prasad and Sons (India) Educational

M. Sc. – I [Mathematics] Semester I

Course Code: P-THP-168 (B)(Elective-I)

Paper-V(B)

Theory of Probability

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives

- **Elementary theory of probability**
- **Discrete and continuous random variable**
- **Discrete probability distribution**
- **Continuous probability distribution**

Course Outcomes:

Students are able to

- **Solve examples on Bays Theorem**
- **Differentiate continuous and discrete random variable**
- **Learn some discrete probability distributions**
- **Learn some continuous probability distributions**

Unit I:

Basic Definitions, Mathematical and statistical probability, Subjective Probability, Axiomatic approach to probability, Theorems on probability, Conditional probability, Multiplication theorem of probability of independent events, Examples, Extended axiom of axiom of addition and axiom of continuity, Baye's theorem.

Unit II:

Random variables, Types , Probability function of discrete random variable,Continuous random variable, Probability density function, Mathematical expectation, Properties of expectation, Variance, Properties of Variance, Moment generating function, Properties of Moment generating function, Cumulants and its properties.

Unit III:

Discrete Probability distributions, Binomial distribution, Mean and Variance of binomial distribution, MGF and CGF of Binomial distribution, Fitting of binomial

distribution, Poisson distribution, Mean and variance of Poisson distribution, MGF and CGF of Poisson distribution, Fitting of Poisson distribution,

Unit IV:

Normal distribution, Properties of normal distribution, Moments of normal distribution, MGF and CGF and fitting of normal distribution.

Reference Books:

1. **S .C. Gupta, V. K. Kapoor**, "Fundamentals of Mathematical Statistics",S. Chand and Sons, New Delhi.
2. **S.C. Gupta, V.K. Kapur**, "Fundamental of Mathematical Statistics",S. Chand and Co. Ltd.
3. **S. C. Saxena**, "Mathematical Statistics", S. Chand and Co. Ltd.

M. Sc. – I [Mathematics] Semester I

Course Code: P-COM-168 (C)(Elective-I)

Paper-V(C)

Combinatorics

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- Basic counting principle.
- Calculation of generating functions.
- Solution of inhomogeneous recurrence relation.
- Pigeonhole Principle.

Course Outcomes:

Students are able to

- **Apply basic counting principle**
- **Do partitions of number**
- **Apply pigeonhole principle**

Unit-I:

Basic counting principles, Simple arrangements and selections, Arrangements and selection with repetition, Distributions, Binomial, and Permutation sand Combinations.

Unit-II:

Generating function models, Calculation of generating functions, Partitions, Exponential generating functions, A summation method, Recurrence relation model,

Unit-III

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

Unit-IV:

Counting with Venn diagrams Inclusion formulae, restricted positions and Rook polynomials, Pigeonhole Principle.

Reference Books:

1. Alan Tucker, "Applied Combinatorics", (3rd edition), John Wiley & sons, New York (1995)
2. V. Krishnamurthy, "Combinatorial, Theory and Applications", East West Press, New Delhi (1989) Scientific, (1996).
3. V.K. Balakrishnan, "Theory and Problems of Combinatories ", Schaum outline series, Mcgraw Hill, New York.

M. Sc. – I [Mathematics] Semester I

Course Code P-LAB-169

Lab Course –I

Lab work (LaTeX Typesetting)

Section –I

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives :

- Latex Installation
- Layout Design
- Packages
- Mathematical Symbols and equations

Course Outcomes

After completing this course students are able to

- Learn different environment in Tex
- Learn how to input maths symbol and equation

Unit I: Introduction to LaTeX, Installation of LaTeX, Layout Design, LaTeX input files, Input file structure, document classes, packages, environments, page styles, Typesetting texts ,Fancy Header, tables.

Unit II: Inline math formulas and displayed equations, Math symbols and fonts, Delimeters, matrices, arrays, Typesetting Mathematical formulae: fractions, Integrals, sums, products, etc. Producing Mathematical Graphics.

Reference Books :

1. Latex Tutorials Indian Tex user group Trivendrum India
2. Latex line by line Tips and Techniques for document processing - Antoni Diller

M. Sc. – I [Mathematics] Semester II

Course Code: P-LIA-264

Paper-VI

Linear Algebra

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives :

- **Basic linear algebra**
- **Linear transformation**
- **Computational Linear Algebra**
- **Inner product space**

Course Outcomes:

Students are able to

- **Find Dimension of vector spaces**
- **Decide regularity of linear maps**
- **Apply Caley Hamilton theorem**
- **Find Jordan Canonical form of given matrix if exists**

Unit-I:

Introduction, Vector spaces, subspaces, Quotient Spaces, Linear combinations and system of linear equations, linear dependence and independence, Bases and dimension, Maximal Linear Independent Subsets.

Unit-II

Linear Transformations, Null spaces, Ranges, The matrix representation of a linear transformation, Composition of linear transformations, Invertibility and Isomorphism, The change of Co-ordinate matrix, Dual spaces.

Unit-III:

Elementary Matrix Operations and elementary matrices, The rank of a matrix, System of linear equations-Theoretical Aspects, System of linear equations-Computational Aspects, Eigen values and Eigen vectors, Diagonalizability, Triangulable Operators, Invariant Subspaces, Cayley-Hamilton Theorem.

Unit-IV:

Inner products and Norms, The Gram-Schmidt Orthogonalization process and orthogonal complements, the adjoint of a linear operator, Bilinear forms, Quadratic forms. Jordan Canonical form-I, Jordan Canonical form-II, The Minimal Polynomial, Rational Canonical form.

Reference Books:

1. S.H. Friedberg, A.J. Insel, L.E. Spence, "Linear Algebra", Prentice-Hall, International, Inc., 3rd Edition.

2. Vivek Sahai and Vikas Bist, "Linear Algebra", Narosa Publishing House, 2nd Edition.

3. S.Lang, "Introduction to Linear algebra", Springer International Edition,2nd Edition.

4. K.Hoffman, R.Kunze, "Linear Algebra", Prentice Hall of India.

5. S.Kumaresan, "Geometrical approach to Linear Algebra",

M. Sc. – I [Mathematics] Semester II

Course Code: P-MIT-265

Paper-VII

Measure and Integration Theory

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives

- Different type of measures and intiegration.
- Relation between derivatives and integration
- Generalization of measure on different abstract spaces
- Signed measure and its properties

Course outcomes

- Know and understand the concept of a sigma-algebra and a measure;
- Know and understand the concept of the Lebesgue measure;
- Know and understand the concept of almost everywhere prevailing properties;
- Understand the Radon-Nikodym theorem;
- Understand the relation between convergence of Lebesgue integrals and pointwise convergence of functions;
- Know and understand products measures and Fubini's theorem;

Unit-I:

Lebesgue outer measure, Measurable sets, Measurable functions, Borel and Lebesgue measurability, Integration of non-negative functions, The general integral, Integration of series, Riemann and Lebesgue Integrals, The four derivatives, Continuous non-differentiable functions, Functions of bounded variations, Differentiation and integration.

Unit-II:

Abstract measure spaces: Measure and outer measure, Extension of measure, Uniqueness of the extension, Completion of measure, Measure spaces, Integration with respect to measure.

Unit-III:

Signed measure and their derivatives: Signed measure and the Hahn-Decomposition, the Jordan decomposition, the Raydon–Nikodym theorem (Statement only).

Unit-IV

Measure and integration in a product spaces: Measurability in a product spaces, The product measure and Fubini's theorem, Lebesgue measure in Euclidean space.

Reference Books:

1. **G.de Barra**, "Measure theory and integration", New Age International (P) Ltd. Publishers.

2. **P.K. Jain and V.P. Gupta**, "Lebesgue measure and Integration" New Age International (P) Ltd. Publishers.

3. **P.R. Halmos**, "Measure theory", Van Mostranel Princeton, 1950.

4.**Inder K. Rana**, "An introduction to measure and Integration", Narosa Publishing House, Delhi,1997.

M. Sc. – I [Mathematics] Semester II

Course Code: P-TOP-266

Paper-VIII

Topology

Credits:04 **Marks : 100** **Total Hours : 60**

Learning objectives:

- **Equivalence set, countable sets and their examples**
- **Topology, Topological spaces, basis for a topology**
- **Continuous functions, compactness, connectedness, uniform continuity**
- **T_1, T_2, T_3 and T_4 spaces**

Course Outcomes :

On successful completion of this course students are able to ,

- **Find cardinality of any set.**
- **Check continuity and apply properties of continuous function**
- **Apply all properties of compactness, connectedness, separation axioms, countability axioms.**

Unit I Basic of Topology:

Cartesian Products, Finite Sets, Countable and Uncountable Sets, Infinite Sets and Axiom of Choice, Well Ordered Sets.

Unit II Topological Spaces:

Basis for a topology, Order topology, Subspace Topology, Product topology, closed sets and limit points, Continuous functions, Metric Topology.

Unit III Connected and Compact Spaces:

Connected spaces, Connected Subspaces of Real Line, Components and Local Connectedness, Compact spaces, Compact Subspaces of the Real Line, Limit point compactness, Local Compactness.

Unit IV Countablity and Separation Axioms:

Countability Axioms, Separation axioms, Normal Spaces, Urysohn's Lemma, Tietze Extension Theorem Metrization Theorem ,Tychonoff's Theorem.

Reference Books:

1. J.R. Munkres, “Topology” Prentice Hall of India, Second Edition.
2. Stephen Willard, "General Topology", Addison-Wesley PublishingCompany, 1970
3. J. Dugundji Topology, Allya and Bacon. (1966) reprinted: Printice Hall of India.
4. W. J. Pervin : Foundations of general topology, academic press Inc. N.Y. H
5. S. T.Hu: Elements of general topology. Holden day Inc. 1965.

M. Sc. – I [Mathematics] Semester II

Course Code: P-PDE-267

Paper-IX

Partial Differential Equations

Credits:04 Marks : 100 Total Hours : 60

Learning Objectives:

- Introduce students to partial differential equations
- To solve linear Partial Differential with different method
- Partial differential equations allow deterministic mathematical formulations of phenomena in physics and engineering as well as biological processes among many other scenarios.
- To present the main results in the context of partial differential equations that allow learning about these models.

Course Outcomes:

On completion of this course successful students will be able to:

- Classify partial differential equations and transform into canonical form;
- Recognize the linear and non-linear partial differential equations of both first and second order by using elementary methods.
- Apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization.
- Recognize real problems by identifying them appropriately from the perspective of partial derivative equations

Unit I:

Introduction, Linear Equation of first order, Charpit's Method, Jacobi's Method, Quasi-Linear Equations, Non-Linear First Order P.D.E, General solution of higher order PDE's with constant coefficients, Special Functions - Bessel's function, Legendre's function.

Unit II:

Introduction, Method of separation of variables, Classification of Second order PDE, One Dimensional Wave Equation, Laplace Equation, Boundary Value Problems, the Cauchy's Problem,

Unit III:

Dirichlet and Neumann Problem for different regions, Harnack's Theorem, Heat Conduction Problem, Duhamel's Principle

Unit IV:

Classification of P.D.E. in the case of *n*-variables, Families of Equipotential Surfaces, Kelvin's Inversion Theorem.

Reference Books:

1. **T. Amarnath,** "An Elementary Course in Partial Differential Equations", (2nd edition), (Narosa Publishing House) [Chapters 1 & 2].

2. **I.N. Sneddon**, "Elements of partial differential equations", (Mc-Graw Hill Book Company).

3. **K. Sankara Rao,** "Introduction to partial differential equation", 3rd edition.

4. **W. E. Williams,** "Partial Differential equations", (Clarendon press oxford)

5. **E. T. Copson,** "Partial differential equations", (Cambridge university press).

6. **H.K. Dass**, "Advanced Engineering Mathematics", S. Chand & Co. Ltd

Course Code: P-COA-268 (A)

Paper-X(A)

Complex Analysis-II

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives:

- Power series, Analytic functions, Fundamental Theorem of Algebra, Maximum Modulus theorem.
- Cauchy's Theorem, Cauchy's Integral Formula Morera's Theorem.
- Singularities, Classification of Singularities, Cauchy's Residue Theorem.
- Convex Functions and Hadamard's three Circles theorem, The Riemann mapping theorem

Course Outcomes:

On completion of this course successful students will be able to:

- Work with functions (polynomials, reciprocals, exponential, trigonometric, hyperbolic, etc) of single complex variable and describe mappings in the complex plane;
- work with multi-valued functions (logarithmic, complex power) and determine branches of these functions;
- Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula;
- Find the Taylor series of a function and determine its circle or annulus of convergence;
- Compute the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line;

Unit -I

Power series, Analytic functions, Branch of a logarithm, Mobius(Bilinear) Transformations and Conformal Mappings Power Series representation of analytic functions, Taylor's Theorem, Cauchy's Estimate, Zeros of an analytic function, Louville's Theorem, Fundamental Theorem of Algebra, Maximum Modulus Theorem.

Unit -II

Index of a closed curve, Cauchy's Theorem, Cauchy's Integral Formula, Higher Order derivatives, Morera's Theorem, The Homotopic version of Cauchy's Theorem and

simple connectivity, Counting of Zeros, The Open mapping Theorem, Goursat's theorem.

Unit -III

Singularities, Classification of Singularities, Laurent's Series, Casorati-Weierstrass Theorem, Residues, Cauchy's Residue Theorem, Evaluation of Integrals, Meromorphic functions, The Arument Principle, Rouche' Theorem, Schwartz Lemma.

Unit -IV

Convex Functions and Hadamard's three Circles Theorem, The Space of continuous Functions, Spaces of Analytic Functions, The Riemann mapping Theorem.

Reference Books:

1. J. B. Conwey: *Functions of One Complex variable*, Springer International Student Edition.

2. S. Ponnusammy and Herb Silverman: *Complex Variables with Applications*, Birkhauser.

3. S. Ponnusammy: *Foundations of Complex Analysis*, 2nd edition, Narosa Publishing House

M. Sc. – I [Mathematics] Semester II

Course Code: P-OPR-268 (B)

Paper-X (B)

Operations Research

Credits:04 Marks : 100 Total Hours : 60

Learning objectives

- Different methods of solving linear programming problems
- Transportation model and optimality analysis
- Assignment model and comparison with transportation model
- Sensitivity analysis in A.P., Traveling salesman problem and game theory, optimization.

Course outcomes:

On completion of this course student should be able to:

- Define and formulate linear programming problems and appreciate their limitations.
- Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action.
- Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.
- 4. Develop mathematical skills to analyse and solve integer programming and network models arising from a wide range of applications.

Unit I:

Definitions, Graphical method, Simplex Method, Duel Simplex Method, Big-M method, Two Phase method.

Unit II:

Introduction to the model, Definition of the Transportation Model, Matrix Terminology, Formulation and solution of transportation models, Variance in transportation problems, Least time transportation Problems, Post Optimality analysis in Transportation, Trans-Shipment Problems.

Unit III:

Definition of Assignment Model, Mathematical representation of the assignment model,Comparison with the Transportation model, Solution of the assignment problem, Hungerian method for solution of the assignment problems

Unit IV:

Formulation and solution of A.M., Variations of the A.P., Sensitivity analysis in A.P., Travelling Salesman problem. Two by Two and three by three Game Theory,Optimization.

Reference Books:

1. **Kanti Swarup**, "Operation Research", S. Chand and Co. Ltd.
2. **H.A. Taha**, "Operation Research", Prentice Hal of India
3. **Premkumar. Gupta**, **D. S. Hira**, "Operation Research", S. Chand and Co. Ltd.

M. Sc. – I [Mathematics] Semester II

Course Code: P-NUT-268 (C)

Paper-X(C)

Number Theory

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives :

- **Elementary number theory**
- **Prime distribution**
- **Arithmetical functions**
- **The power and bell series**

Course Outcomes :

Students are able to

- **Apply Chinese Remainder Theorem**
- **Solve Quadratic Congruence's**
- **Use $\varphi(n)$ and $\tau(n)$**

Unit I:

Theory of congruences, Basic properties of congruences, Binary and decimal representation of integers, Linear congruences and Chinese Remainder theorem, Pierre de Fermat theorem, Fermat's little theorem and pseudoprimes, Wilson's theorem.

Unit-II:

The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots, Euler's criterion, The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruences with composite moduli, The equation *x*^2+*y*^2=*z*^2

Unit III:

Arithmatical Functions & Dirichlet Multiplication The Mobius function, The Eular Totient function, The Managoldt function, Dirichlet Multiplication,

Unit-IV Multipicative function, Inverse of Completely multiplicative function, Liouville's function, The divisor function, Formal power series, The Bell series, The Selberg identity.

Reference Books:

1. David M. Burton, "*Elementary Number Theory*" Tata McGraw-Hill Pub. VI Edition.

2. Tom M. Apostol, "*Introduction to Analytic number theory*" Narosa Publishing house 1980.

3. A course in arithmetic- J.P. Serre. GTM Vol.7, Springer Verlage 1973

M. Sc. – I [Mathematics] Semester II

Course Code P-LAB-269

Lab Course –II

Lab work-II (**Writing and Presentation using LaTeX**)

Credits:04 **Marks : 100** **Total Hours : 60**

Learning Objectives :

- Document Class for different environment
- Header and footer

Course Outcomes

After completing this course students are able to

- Create document for paper,book,thesis writing
- To create beamer file of presentation

Unit I:

Document classes for paper writing, thesis, books, etc. Table of contents, index, bibliography management, hypertext, pdf pages, geometry, fancy header and footer, Verbatim, itemize, enumerate, boxes, equation number.

Unit II:

Beamer class, beamer theme, frames, slides, pause, overlay, transparent, handouts and presentation mode.

Reference Books :

1. Latex Tutorials Indian Tex user group Trivendrum India
2. Latex line by line Tips and Techniques for document processing - Antoni Diller