

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur  
BoS in Mathematics



Curriculum for  
M.Sc.-I (Mathematics)  
CBCS Pattern  
w.e.f. 2022-2023

# Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

## BoS in Mathematics

### 1. Introduction:

M. A. / M. Sc. Mathematics program is of minimum 110 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 . 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 whereas 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

<b>5. Duration of the Course:</b>	Two years
<b>6. Eligibility of the Course:</b>	<b>For M.Sc. I :</b> B.Sc. with Mathematics as principal Subject at degree level.
<b>7. Strength of the Students:</b>	30 (+3 )
<b>8. Fees for Course:</b>	As per UGC/University/College rules.
<b>9. Period of the Course:</b>	As per UGC/University/College rules
<b>10. Admission / Selection procedure:</b>	As per UGC/University/College rules
<b>11. Teacher's qualifications:</b>	As per UGC/University/College rules
<b>12. Standard of Passing:</b>	As per UGC/University/College rules
<b>13. Nature of question paper with scheme of marking:</b>	As per UGC/University/College rules
<b>15. List of book recommended:</b>	Included in syllabus

**16. List of Laboratory Equipments,**

**Instruments, Measurements etc.:** Latex Software with one computer Lab of 20 pcs

**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 2023(Fourth Revision)**

Chairman Board of Studies  
Mathematics  
**(Dr. M. S. Wavare)**

### **List of BoS Member (2021-2024)**

1. Dr. Bhalchandra . D. Karande (VC Nominee)  
HoD ,Department of Mathematics ,  
Maharashtra Udaygiri Mahavidyalaya, Udaygir Dist Latur
2. Dr. S D Kendre (Subject Expert)  
Department of Mathematics,  
Savitribai Phule Pune University ,Pune
3. Dr. M T Gophane (Subject Expert)  
Department of Mathematics  
Shivaji University, Kolhapur.
4. Dr. Nitin S Darkunde, (co-option)  
School of Mathematical Sciences, S R T M U Nanded
5. Dr. A A Yadav (Other members of the staff of the same faculty.)  
Rajarshi Shahu Mahavidyalaya(Autonomous) , Latur
6. Prof .S M Shinde (Student Alumni)  
Government College of Engineering , Amravati ,Dist Amaravati
7. Mr. S SRanmal (Industry Expert )  
Sungrace Computers Pvt Ltd, Pune
8. Prof. Nishank S. Pimple  
Rajarshi Shahu Mahavidyalaya(Autonomous) , Latur
9. Mr. Anant Suryawanshi  
Rajarshi Shahu Mahavidyalaya(Autonomous) , Latur
10. Mr. N D Kapale  
Rajarshi Shahu Mahavidyalaya(Autonomous) , Latur
11. Miss. Shivkanya D. Shinde  
Rajarshi Shahu Mahavidyalaya(Autonomous) , Latur

# Program Specific Outcomes

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

PS01	To promote collaborative learning and application of mathematics to real life situation.
PS02	They can upgrade the knowledge to qualify CSIR-NET/SET/GATE in Mathematical Sciences.
PS03	They will get tune with further studies of their area of interest.
PS04	They can be good teacher in Mathematics subject .
PS05	They can get placed in job of Scientific Computing /Data Analyst etc .
PS06	Comprehend and write effective reports and design documentation related to mathematical research and literature, make effective presentations.
PS07	To implant in students inventive qualities, teamwork, and ethical practices in order to achieve society standards.
PS08	To provide a high-quality education by incorporating projects, participatory learning, and cutting-edge software tools into successful teaching and learning processes.
PS09	To provide a comprehensive curriculum which will educate students towards becoming great scientific professionals.
PS010	To inculcate the interest for mathematics in students and to prepare them for potential research.

**Annexure 'A'**

Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)

Department of Mathematics

M.Sc. I (CBCS) Semester I

Curriculum Structure with effect from June, 2022

Course Code	Paper No.	Title of the course	Hours/ Week	Marks (100)		Credits
				In Sem	End Sem	
P-GRT-164	I	Core Course: Group Theory	05+ 1 Tutorial	40	60	04
P-REA-165	II	Core Course: Real Analysis	05+ 1 Tutorial	40	60	04
P-ODE-166	III	Core Course: Ordinary Differential Equations	05+ 1 Tutorial	40	60	04
P-COA-167	IV	Core Course: Complex Analysis	05+ 1 Tutorial	40	60	04
P-THP168	V	Theory of Probability	05+ 1 Tutorial	40	60	04
P-LAB-169	Lab-I	Core Course: Lab Work-I(Latex Typesetting )	04	40	60	02
P-SEM-170		Seminar	01	--	25	01
P-TUT-171	Tutorial	Tutorial	05	--	25	1
		<b>Total Stay Hours</b>	<b>35</b>		<b>Total Credits</b>	<b>24</b>

**Student Stay Hours: 35/Week**

**M.Sc. I (CBCS) Semester II**  
**Curriculum Structure with effect from June, 2022**

Course Code	Paper Number	Title of the course with paper number	Hours/Week	Marks (100)		Credits
				In Sem	End Sem	
P-LIA-264	VI	Core Course: Linear Algebra	05+ 1 Tutorial	40	60	04
P-ANT-265	VII	Core Course: Analytical Number Theory	05+ 1 Tutorial	40	60	04
P-TOP-266	VIII	Core Course: Topology	05+ 1 Tutorial	40	60	04
P-PDE-267	IX	Core Course: Partial Differential Equations	05+ 1 Tutorial	40	60	04
P-MIT-268	X	Core Course: Measure and Integration Theory	05+ 1 Tutorial	40	60	04
P-LAB-269	Lab-II	Lab work (Writing and Presentation using LaTeX)	04	40	60	02
P-SEM-270		Seminar	01	---	25	01
P-TUT-271		Tutorial		--	25	01
		<b>Total Credits</b>	<b>35</b>			<b>24</b>

**Student Stay Hours: 35/Week**



## M. Sc. – I [Mathematics] Semester I

Course Code: P-GRT-164

### Paper-I

### Group Theory

#### Learning Objectives:

- To study basic group theory, Action on group
- To study Cayley theorem
- To study Fundamental Theorems of Finite Abelian group
- To study Sylow's theorem

#### Course Outcomes:

After successful completion of this course students can able to

- Apply Action mapping and fundamental theorems of homomorphism
- Solve examples on internal and external direct product .
- Solve examples on Sylows 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 [15 Lectures]

#### Unit-II:

Isomorphism theorems, Automorphism, Conjugacy and  $G$ -sets, Normalseries, Solvable groups, Nilpotent groups. [15 Lectures]

#### Unit-III

Group Homomorphism, First Isomorphism Theorem, Fundamental Theorem of Finite Abelian Groups, Permutation Groups, Cyclic decomposition, Alternating group  $A_n$ , [15 Lectures]

#### Unit-IV

Structure of groups, Direct product, Finitely Generated Abelian Groups, Invariants of a finite abelian group, Sylow Theorems and its applications [15 Lectures]

#### Recommended Book

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

### **Reference Books**

1. **Joseph A. Gallian**, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa, 1999.
2. **I. S. Luthar and I. B. S. Passi**, "Algebra-Vol. 1: Groups", Narosa, New Delhi, 1996.
3. **V.K. Khanna, S.K. Bhambri**, "A Course in Abstract Algebra", Vikas Publishing House.  
(Second Edition)
4. **David Dummit and Richard Foote**, "Abstract Algebra", John Wiley and Sons.

## M. Sc. – I [Mathematics] Semester I

Course Code: P-REA-165

### Paper-II

#### Real Analysis

##### Learning objectives

- To study the concept of limit of sequences of functions and function of several variables.
- To find, disc of convergence, radius of convergence of power series and its applications.
- To compute derivatives and integrals of higher dimensional functions.
- To Study Stokes and Gauss Divergence Theorem

##### Course Outcomes:

After Successful completion of this course 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
- Apply Stokes and Gauss Divergence Theorem

**Unit I :** 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.

[15 Lectures]

**Unit II:** 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  $R$ .

[15 Lectures]

**Unit III:** Functions of several variables, Linear transformations, Differentiation, Contraction principle, The inverse function theorem, The implicit function theorem and their applications.

[ 15 Lectures ]

**Unit IV:** 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. [15 Lectures]

**Recommended Books**

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

**Reference books :**

1) Mathematical Analysis, Apostol, Second Edition, Narosa Publishing House.

2) Calculus Vol. II , Tom M. Apostol, Second Edition Wiley India Pvt. Ltd

3) W.Fleming, Functions of several Variables,2nd Edition ,Springer Verlag, 1977.

4)J.R.Munkres, Analysis on Manifolds.

## M. Sc. – I [Mathematics] Semester I

Course Code: P-ODE-166

### Paper-III

## Ordinary Differential Equations

### 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 be able to

- Recognize definition and properties of initial value problems
- Recognize definition and properties of linear dependence and independence, Wronskian, singular points, regular singular points, Lipschitz constant
- Apply power series solution method, method of successive approximation
- Recognize properties of Euler 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 [10 Lectures]

### Unit II

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. [20 Lectures]

### Unit III

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). [15 Lectures]

#### **Unit IV**

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.[15 Lectures ]

#### **Recommended Book:**

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

#### **Reference Books**

- 1.**G. F. Simmons and S. G. Krantz**, "Differential Equations", (Tata Mc Graw-Hill ).
- 2.**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

#### Learning Objectives:

- To study Complex Field, Algebra of complex numbers,
- To study Stereographic Projection, Transformation & Mapping Properties.
- To Discuss Analyticity, Harmonic Functions
- To evaluate Line Integrals using Cauchy's Theorems
- To Compute Singularities and Classify it

#### Course Outcomes:

On successful completion of this course 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 .
- Learn techniques of complex analysis that make practical problems easy
- know the condition(s) for a complex variable function to be analytic and/or harmonic.
  - Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula.
  - 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

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. Stereographic Projection, Linear Fractional, Transformation, Other Mappings, The Exponential Function, Mapping Properties [15 Lectures]

#### Unit II

The Logarithmic Function, Complex Exponents, Power series, Analytic functions, Analyticity, Harmonic Functions, Sequences of Functions, Uniform Convergence, Maclaurin and Taylor Series, Operations on Power series. Taylor's Theorem, Cauchy's Estimate, Zeros of an analytic function, Louville's Theorem, Fundamental Theorem of Algebra, Maximum Modulus Theorem. [15 Lectures]

### **Unit -III**

Curves , Parameterizations, Line Integrals, Cauchy's Theorems. Index of a closed curve, Cauchy's Theorem, Cauchy's Integral Formula, Morera's Theorem, The Homotopic version of Cauchy's Theorem and simple connectivity, Counting of Zeros, The Open mapping Theorem, Goursat's theorem. [15 Lectures]

### **Unit -IV**

Singularities, Classification of Singularities, Laurent's Series, Casorati-Weierstrass Theorem, Residues, Cauchy's Residue Theorem, Evaluation of Integrals, Meromorphic functions, The Argument Principle, Rouché's Theorem, Schwarz Lemma. Convex Functions and Hadamard's three Circles Theorem, The Riemann mapping Theorem. [15 Lectures]

### **Recommended Book:**

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

### **Reference Books**

- 1.**Silverman Herb**, "Complex Analysis",
- 2.**John B. Conway**, "Function of one complex variable", Narosa Pub. House , 1980.
- 3.**Lars V. Ahlfors**, "Complex Analysis", McGraw Hill Co.
- 4.**S. Ponnusamy**, " Foundations of Complex Analysis", Narosa Publishing House.



## M. Sc. – I [Mathematics] Semester I

Course Code: P-THP-168

### Paper-V

#### Theory of Probability

##### Learning objectives

- To acquire knowledge Elementary theory of probability
- To differentiate discrete and continuous random variable
- To Discrete probability distribution
- Continuous probability distribution

##### Course Outcomes:

After successful completion of this course 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. [15 Lectures]

##### 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. [15 Lectures]

##### 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,[15 Lectures]

##### Unit IV:

Normal distribution, Properties of normal distribution, Moments of normal distribution, MGF and CGF and fitting of normal distribution. [15 Lectures]

**Recommended Book**

**1. Ronald E. Walpole, Raymond H Myers** , “Probability and Statistics for Engineers and Scientist” Fourth Edition

**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-LAB-170

Lab Course –I

Lab work (LaTeX Typesetting)

Section -I

### **Learning Objectives:**

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

### **Course Outcomes**

After completing this course students are able to

- Install LaTeX software
- Learn different environment in LaTeX
- Learn how to do input maths symbol and equation
- To obtain output as a pdf

### **Section I:**

Introduction to LaTeX, Installation of LaTeX, Layout Design, LaTeX input files, Inputfile structure, document classes, packages, environments, page styles, Typesetting texts, Fancy Header, tables.

### **Section II:**

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

### **Recommended 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

#### Learning objectives:

- To Study Basic linear algebra
- To acquire knowledge of Linear transformation
- To study Computational Linear Algebra
- To Study Inner product space

#### Course Outcomes:

After successful completion of this course Students are able to

- Find Dimension of vector space
- 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. [15 lecture ]

#### 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. [15 lecture ]

#### 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. [15 lecture ]

#### 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. [15 lecture ]

**Recommended Book:**

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

**Reference Books:**

1. **Vivek Sahai and Vikas Bist**, "Linear Algebra", Narosa Publishing House, 2nd Edition.
2. **S.Lang**, "Introduction to Linear algebra", Springer International Edition, 2nd Edition.
3. **K.Hoffman, R.Kunze**, "Linear Algebra", Prentice Hall of India.
4. **S.Kumaresan**, "Geometrical approach to Linear Algebra"

## M. Sc. – I [Mathematics] Semester II

Course Code: P-ANT-265

Paper -VII

### Analytical Number Theory

#### Learning Objectives:

- To Acquire knowledge in elementary number theory
- To study Prime distribution
- Arithmetical functions
- The power and bell series

#### Course Outcomes:

After successful completion of this course Students are able to

- Apply the basic properties of Congruence's
- Apply Chinese Remainder Theorem
- Solve Quadratic Congruence's
- Use  $\varphi(n)$  and  $\tau(n)$

#### Unit I:

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

[15 lectures]

#### 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 congruence's with composite moduli, The equation  $x^2 + y^2 = z^2$

[15 lectures]

#### Unit III:

Arithmetical Functions & Dirichlet Multiplication The Mobius function, The Euler Totient function, The Managoldt function, Dirichlet Multiplication,

[15 lectures]

#### Unit-IV

Multiplicative function, Inverse of Completely multiplicative function, Liouville's

Function, The divisor function, Formal power series, The Bell series, The Selberg identity.  
[15 lectures]

**Recommended Books:**

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

**Reference Books:**

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

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

## M. Sc. – I [Mathematics] Semester II

Course Code: P-TOP-266

### Paper-VIII

#### Topology

##### 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.
- Understand various Topological Spaces

##### Unit I

Cartesian Products, Finite Sets, Countable and Uncountable Sets, Infinite Sets and Axiom of Choice, Well Ordered Sets. [15 lectures]

##### Unit II

Basis for a topology, Order topology, Subspace Topology, Product topology, closed sets and limit points, Continuous functions, Metric Topology. [15 lectures]

##### Unit III

Connected spaces, Connected Subspaces of Real Line, Components and Local Connectedness, Compact spaces, Compact Subspaces of the Real Line, Limit point compactness, Local Compactness. [15 lectures]

##### Unit IV

Countability Axioms, Separation axioms, Normal Spaces, Urysohn's Lemma, Tietze Extension Theorem Metrization Theorem, Tychonoff's Theorem. [15 lectures]

##### Recommended book:

1. **J.R. Munkres**, "Topology" Prentice Hall of India, Second Edition.



**Reference Books:**

1. **Stephen Willard**, "General Topology", Addison-Wesley Publishing Company, 1970
2. **J. Dugundji Topology**, Allyn and Bacon. (1966) reprinted: Prentice Hall of India.
3. **W. J. Pervin**, Foundations of general topology, academic press Inc. N.Y. H
4. **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

##### 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.

[15 lectures]

##### 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,

[15 lectures ]

**Unit III:**

Dirichlet and Neumann Problem for different regions, Harnack's Theorem, Heat Conduction Problem, Duhamel's Principle [15 lectures ]

**Unit IV:**

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

[15 lectures ]

**Recommended book:**

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

**Reference Books:**

1. **I.N. Sneddon**, "Elements of partial differential equations", (Mc-GrawHill Book Company).

2. **K. Sankara Rao**, "Introduction to partial differential equation", 3<sup>rd</sup> edition.

3. **W. E. Williams**, "Partial Differential equations", (Clarendon pressoxford)

4. **E. T. Copson**, "Partial differential equations", (Cambridge universitypress).

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

## M. Sc. – I [Mathematics] Semester II

Course Code: P-MIT-267

### Paper -X

#### Measure and Integration Theory

##### Learning objectives

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

##### Course outcomes

On completion of this course student should be able to

- 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.

[20 lecture ]

##### 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.

[15 lecture ]

##### Unit-III:

Signed measure and their derivatives: Signed measure and the Hahn-Decomposition, the Jordan decomposition, the Raydon–Nikodym theorem(Statement only). [15 lecture ]

##### 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.

[10 lecture ]

**Recommended Book:**

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

**Reference Books:**

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

2.**P.R. Halmos**, "Measure theory", Van Nostrand Princeton, 1950.

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

## **M. Sc. – I [Mathematics] Semester II**

Course Code P-LAB-269

Lab Course –II

Lab work-II

### **(Writing and Presentation using LaTeX)**

#### **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

#### **Section 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.

#### **Section II:**

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

#### **Recommended Book:**

1. Latex Tutorials Indian Tex user group Trivendrum India

#### **Reference Books:**

1. **Antoni Diller** “Latex line by line Tips and Techniques for document processing”