Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

BoS in Mathematics


# Syllabus 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. TheM.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 (+3 ) |
| **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.:** 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 2022(Third 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 ,
   Maharastra 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. Vishnu R Sonawane
    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:

| | |
|---|---|
| PSO1 | To promote collaborative learning and application of mathematics to real life situation. |
| PSO2 | They can upgrade the knowledge to qualify CSIR-NET/SET/GATE in Mathematical Sciences. |
| PSO3 | They will get tune with further studies of their area of interest. |
| PSO4 | They can be good teacher in Mathematics subject . |
| PSO5 | They can get placed in job of Scientific Computing /Data Analyst etc . |
| PSO6 | Comprehend and write effective reports and design documentation related to mathematical research and literature, make effective presentations. |
| PSO7 | To implant in students inventive qualities, teamwork, and ethical practices in order to achieve society standards. |
| PSO8 | To provide a high-quality education by incorporating projects, participatory learning, and cutting-edge software tools into successful teaching and learning processes. |
| PSO9 | To provide a comprehensive curriculum which will educate students towards becoming great scientific professionals. |
| PSO10 | 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 | 06 | 40 | 60 | 04 |
| P-REA-165 | II | Core Course: Real Analysis | 06 | 40 | 60 | 04 |
| P-ODE-166 | III | Core Course: Ordinary Differential Equations | 06 | 40 | 60 | 04 |
| P-COA-167 | IV | Core Course: Complex Analysis | 06 | 40 | 60 | 04 |
| Discipline Specific Elective-I 168(A/B/C/ D/E) | V(A)<br>V(B)<br>V(C)<br>V(D)<br>V(E) | DSE: Choose any one<br>Discrete Mathematics(A)<br>or<br>Theory of Probability(B)<br>or<br>Combinatorics (C)<br>Or<br>Cryptography(D)<br>Or<br>Differential Geometry (E) | 06 | 40 | 60 | 04 |
| P-LAB-169 | Lab-I | Core Course:<br>Lab Work-I(Latex Typesetting ) | 04 | 40 | 60 | 04 |
| P-SEM-170 | | Seminar | 01 | -- | 25 | 01 |
| | | Total Credits | | | | 25 |

**Student Stay Hours: 34/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 | 06 | 40 | 60 | 04 |
| P-ANT-265 | VII | Core Course: Analytical Number Theory | 06 | 40 | 60 | 04 |
| P-TOP-266 | VIII | Core Course: Topology | 06 | 40 | 60 | 04 |
| P-PDE-267 | IX | Core Course: Partial Differential Equations | 06 | 40 | 60 | 04 |
| Discipline Specific Elective-II<br>P-GRT-268 (A)<br><br>P-OPR-268 (B)<br><br>P-MIT-268 (C)<br>P-ALG-268 (D)<br><br>P-SPF-268(E) | X(A)<br><br>X(B)<br><br>X(C)<br><br>X(D)<br><br>X(E) | DSE : Choose any one<br>Operations Research (A)<br>Or<br>Stochastic Processes (B)<br>Or<br>Measure and Integration Theory (C)<br>Or<br>Algebraic Geometry(D)<br>Or<br>Special Functions (E) | 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: 34/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 Caley 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 Publicing 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 d erivatives 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, Apostal, 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 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 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 .[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. Codington**, "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, Rouche' Theorem, Schwartz 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. Convey**, "Function of one complex variable", Narosa Pub. House , 1980.

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

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

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

**Course Code: P-DIM-168(A)**

**Paper-V(A)**

**Discipline Specific Elective**

**Discrete Mathematics**

**Learning Objectives:**

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

**Course Outcomes:**

On successful completion of this course students will be 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. [15 Lectures]

**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, Sub graphs, Walks, Paths and Circuits, Connected and Disconnected graphs, Euler graphs, More on Euler graphs, Operations on graphs, Hamiltonian paths and circuits [15 Lectures]

**Unit III:**

The travelling salesman problem, Trees, Properties of trees, Pendant vertices in a tree, Distance and centrein 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. [15 Lectures]

**Unit IV:**

Matrix representation of graphs, Incidence matrix, Sub matrices of A(G),Circuit matrix, Fundamental circuit matrix and its rank, An application to as witching network, Adjacency matrix, Directed graphs, Types, Digraphs and binary relations, Directed paths and Connectedness, Euler digraphs, Trees with directed edges, Fundamental circuits in digraphs. [15 Lectures]

**Recommended books:**


1. **Narsingh Deo**, "Graph theory with applications to engineering and computer science", Prentice –Hall of India Pvt. Ltd.


**Reference books**


1. **C L Liu**, "Elements of Discrete Mathematics", Tata McGraw-Hill, Publishing Company (Second Edition).
2. **J.P. Tremblay, R. Manohar**, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt.Ltd.
3. **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)**

**Paper-V(B)**
**Discipline Specific Elective**

## 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-COM-168 (C)**

**Paper-V(C)**

**Discipline Specific Elective**

**Combinatorics**

**Learning Objectives:**

- To study Basic counting principle.
- To Calculate generating functions.
- To solve inhomogeneous recurrence relation.
- To Study Pigeonhole Principle.

**Course Outcomes:**

After successful completion of this course Students are able to

- Apply basic counting principle
- Do partitions of natural number
- Solve recurrence relation
- Apply pigeonhole principle

**Unit-I:**

Basic counting principles, Simple arrangements and selections, Arrangements and selection with repetition, Distributions, Binomial, and Permutation sand Combinations. [15 Lectures]

**Unit-II:**

Generating function models, Calculation of generating functions, Partitions, Exponential generating functions, A summation method, Recurrence relation model [15 Lectures]

**Unit-III**

Divide and conquer relations, Solution of inhomogeneous recurrence relation, Solution with generating functions. [15 Lectures]

**Unit-IV:**

Counting with Venn diagrams Inclusion formulae, restricted positions and Rook polynomials, Pigeonhole Principle. [15 Lectures]

**Recommended Book:**

1. **Alan Tucker**, "Applied Combinatorics", (3rd edition), John Wiley &sons, New York (1995)

**Reference Books:**

1. **V. Krishnamurthy**, "Combinatorial, Theory and Applications", EastWest Press, New Delhi (1989) Scientific, (1996).
2. **V.K. Balakrishnan**, "Theory and Problems of Combinatories", Schaumoutline series, Mcgraw Hill, New York.

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

**Course Code: P-CRY-168 (D)**

**Paper-V(D)**

**Discipline Specific Elective**

**Cryptography**

**Learning Objective(s):**

- Private-Key (Symmetric) Encryption .
- cryptographic assumptions in cyclic groups,.Public-Key (Asymmetric) Cryptography
- RSA cryptosystem.
- The continued fraction method, The Quadratic fraction method

**Course Outcome(s):**

After successful completion of this course Students are able to

- Apply Diffie-Hellman key exchange, the model and definitions, hybrid encryption and KEM/DEM, El Gamal cryptosystem
- Do Shamir secret sharing scheme and its applications .
- Use the Rho method ,
- Apply Fermat factorization and factor bases

**Unit I :**

Introduction: Historical ciphers and their cryptanalysis, adversarial models and principles of defining security. Private-Key (Symmetric) Encryption: Computational security, defining secure encryption, constructing secure encryption, pseudo randomness, chosen plaintext attacks (CPA), constructing CPA-secure encryption, modes of operation, CBC versus CTR, Chosen cipher text attacks. [15 Lectures]

**Unit II :**

Number Theory: Primes, factoring and RSA, cryptographic assumptions in cyclic groups,.Public-Key (Asymmetric) Cryptography: Diffie-Hellman key exchange, the model and definitions, hybrid encryption and KEM/DEM, El Gamal cryptosystem, RSA cryptosystem,

**Unit III :**

Prinality and Factoring: Pseudo primes, The Rho method, Fermat factorization and factor bases ,The continued fraction method, The Quadratic fraction method [15 Lectures]

**Unit IV :**

Digital Signatures: Definition, Hash and sign, RSA signatures: textbook RSA, hashed RSA, security with ROM, certificates and public-key infrastructures, SSL/TLS. Secret Sharing: Shamir secret sharing scheme and its applications. [15 Lectures]

**Recommended Book:**

1.**Atul Kahate,** "Cryptography and Network Security", Tata McGraw-Hill, 2003.

**Reference Books :**

1. **Bruce Schneier,** "Applied Cryptography", John Wiley & Sons Inc, 2001.
2. **Charles B. Pfleeger, Shari Lawrence Pfleeger**, "Security in Computing", Third Edition, Pearson Education, 2003.
3. **William Stallings,** "Cryptography And Network Security – Principles and Practices", Prentice Hall of India, Third Edition, 2003.

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

**Course Code: P-DIG-168 (E)**

**Paper-V(E)**

**Discipline Specific Elective**

**Differential Geometry**

**Learning Objective(s):**

- To study Elementary Differential Geometry
- To acquire knowledge about Curves and Vector fields in $R^3$
- To Study torsion and frenet formulae

**Course Outcome(s):** After completing this course, the student will be able to:

- Use Linear Mapping and Transformations
- study curves and vector fields in three dimensional spaces
- Discuss Calculus of Vector fields
- Study of Geometry of Curves
- Compute Singular points and can do their classification

**Unit-I**

Vector space, Euclidean Space, Matrices and Group, Vectors in $R^3$and $R^n$and their Algebra, Orientation in $R^3$ and $R^n$ , Real and Vector-valued Functions and their calculus, Metric Spaces and Topological Spaces, Linear Mappings and Transformations, Dual of a vector space [15 Lectures ]

**Unit-II**

Differentiable curve and its parametric representation, answers to some Questions related to the nature of a Curve, Tangent vectors and Vector Fields in $R^3$, Directional Derivatives, Arc Length and tangent Vector. [15 Lectures ]

**Unit-III**

Osculating plane and the circle, curvature vector, principal normal vector, torsion and frenet formulae, Frenet approximate of curves and its projections, piecewise regularity of curves: Singular points and their classification due to gauss, Frenet formulae for an arbitrary curve. [15 Lectures ]

**Unit-IV Geometry of curves**

Translation, Rotation and Isometries in $R^n$, mapping F* induced from F, Fundamental Theroem on curves in $R^3$, congruent curves, Content between two curves, curve and a plane or a surface, Generalized helixes and spherical curves

[15 Lectures ]

**Recommended Books :**

1. **Nirmala Prakash**, "Differential Geometry an integrated Approach",Tata McGraw-Hill Company Limited

**Reference Books :**

1. **Dr. Kailash Sinha and Jagdish Prasad**, "An Introduction to Differential Geometry, Shalini Prakashan Meerut

2. **S Axler F W Gehring K A Ribet** , "Elementry Topics in Differential Geometry" Springer

3. **Kuhnel, Wolfgangby** ,"Differential Geometry: Curves – Surfaces – Manifolds", Student mathematical library, Providence, RI: American Mathematical Society, 2002

**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, Delimeters, 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 processand 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"

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**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 Eular Totient function, The Managoldt function, Dirichlet Multiplication, [15 lectures]

**Unit-IV**

Multipicative 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 PublishingCompany, 1970
2. **J. Dugundji Topology**, Allya and Bacon. (1966) reprinted: Printice 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 orderby 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", 3rdedition.

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-OPR-268 (A)**

**Paper-X (A)**

**Operations Research**

**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.
- Develop mathematical skills to analyze 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. [15 lectures ]

**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. [15 lectures]

**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 [15 lectures ]

**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.

[15 lectures]

**Recommended Book:**

1.**KantiSwarup**, "Operation Research", S. Chand and Co.Ltd.

**Reference Books:**

1.**H.A. Taha**, "Operation Research", Prentice Hal of India

2.**Premkumar. Gupta**, **D. S. Hira**, "Operation Research", S. Chand andCo. Ltd.

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

**Course Code: P-STP-268(B)**

**Paper-X(A)**

**Stochastic Processes**

**Learning Objectives:**

- To study Stationary Distributions.
- To learn and to understand stochastic processes predictive approach.
- To develop an ability to analyze and apply some basic stochastic processes for solving real life situations.

**Course Outcomes:**

After completion of the course students will able to:

- Understand the stochastic processes, Markov chains, Transition probability matrix and various types of states.
- Explain Random walk, Gambler ruins problem and apply Poisson process in real life situations.
- Formulate and solve problems which involve setting up stochastic models.
- Understand renewal theory and branching processes with applications.

**Prerequisites:** This paper requires basics of exploratory data analysis, data types, basic probability etc.

**Unit I:**

Introduction to stochastic Processes (SP's) Classification of SP's according to State space & time domain. Markov chain, countable state Markov chain, calculation of n-step transition probability & its limit. Chapman-Kolmogorov equation, Stationary distribution, classification of states, criteria for various states, Ergodic theorem. [15 Lectures]

**Unit II:**

Random walk & gambler's ruin problem, absorbing and reflecting barriers, probability of eventual absorption, expected duration of game, random walk in 2 & 3 dimension. First passage time distribution. Poisson process, properties of Poisson process.

[15 Lectures]

**Unit III:**

Discrete state space & continuous time Markov chain, pure birth, pure death, Birth and death process. Continuous state space, continuous time Markov chain, Wiener process, Wiener process as a limit of random walk, differential equation of Wiener process, first passage problem in Wiener process. [15 Lectures]

**Unit IV:**

Renewal and delayed renewal processes, related theorems, key renewal theorem (withoutproof) and its application. Galton-Watson Binaymi Branching process. Probabilityof ultimate extinction. Stationary Process: Weak Stationary and strong stationary processes. [15 Lectures]

**Recommended Books**

1**) Medhi, J.** Stochastic Processes, Wiley Eastern**.** (1994).

2) **Ross, S.** Introduction to Probability Models, 6th Ed. Academic Press(2005).

**Reference Books:**

1) **Taylor and Karlin** "An Introduction to Stochastic Modeling" Aca. Press (1984)

2) **Bhat, B. R.** "Stochastic Models: Analysis and Applications" New Age International, India, (2000).

3) **Adke, S. R. and Manjunath, S.M. "**An Introduction to finite Markov Processes" Wiley Eastern, (1984) .

4) **Parzen E. "**Stochastic Proces" Holden-Pay, (1962).

5) **Karlin & Taylor, A.** "First Course in Stochastic Proces", (Vol.1) Academic Press, (1975).

6) **Cinlar E.** Introduction to Stochastic Process, Prentice Hall, (1975).

7) **Srinivas and Mehta** "Stochastic Processes" Tata McGraw Hill, New Delhi, (1976).

8) **Feller, W. "**Introduction to Probability and its Applications" (Vol.1) Wiley Eastern **.(**1968).

9) **Harris, T.E.** "The Theory of Branching Processe", (Springer-Verlag) (1963).

10) **Hoel, P.G., Port, S. C. and Stone, C. J.** "Introduction to Stochastic Processes" Houghton Miffin & Co. (1972).

11) **Jagers, P.** "Branching Processes with Biological Applications" Wiley. (1974).

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

**Course Code: P-MIT-265**

**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.

[15 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.

[15 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 Mostranel 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-ALG-268 (D)**

**Paper-X(D)**

**Elective Course - Algebraic Geometry**

**Learning Objective(s):**

- This course introduces the elementary concepts of Algebraic Geometry
- To understand

**Course Outcome(s):**

After completing this course, the student will be able to:

- Study Affine varieties Affine and Projective Varieties
- Study Projective varieties
- Discus about families and Parameter Space
- do study of ideals of varieties, Irreducible decomposition

**Unit-I Affine and Projective Varieties**

A Note about our fields, Affine space and affine varieties, projective space and projective varieties, linear spaces, finite sets, hypersurfaces, analytic subvarieties and submanifolds, the twisted cubic, rational normal curves, determinantal Representation of the Rational Normal curve, The family of plane conics, A Synthetic Construction of the rational Normal curve, Other Rational curves, varieties defined over subfields of K

[15 lectures]

**Unit-II Regular Functions and maps**

The Zariski Topology, Regular Functions on a Affline Variety, projective varieties, regular maps: The Veronese map, determinantal representation of Veronese varieties, subvarieties of Veronese varieties, the segre maps, subvarieties of segrevarities, products of varieties, graphs, fiber products, combinations of Veronese and segre maps

[15 lectures]

**Unit-III Cones, projections and more about products, Families and Parameter Space**

Cones, quadrics, projections, more projections, constructible sets, Families and Parameter spaces: Families of varieties, the universal hyperplane, , The universal

hyperplane section, parameter spaces of hypersurfaces, universal families of hypersurfaces, family of lines. [15 lectures]

**Unit-IV Ideals of Varieties, Irreducible decomposition and the Nullstellensatz**

Generating Ideals, Ideals of Projective Varieties, Irreducible varieties and irreducible decomposition General objects: general projections, general twisted cubics, double point loci, A little algebra, restatements and corollaries. [15 lectures]

**Recommended Book:**

1. **Joe Harris ,Springer** "Algebraic Geometry"

**Reference Books**

1. **Hartshorne Springer–Verlag** "Algebraic geometry. Graduate Texts in Mathematics"

2. **Shafarevich**, "Basic algebraic geometry" Springer–Verlag, 1994.

3. **Vakil R** " Foundations of algebraic geometry" , Available online: math.stanford.edu/~vakil/216blog , 2012.

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

**Course Code: P-SEF-269 (E)**

**Paper-V(E)**

**Special Functions**

**Max. Periods: 60(04 Credits)**

**Learning Objective(s):**

- This course introduces the elementary concepts of Special Functions .

**Course Outcome(s):**

After completing this course, the student will be able to:

- Solve example from beta and Gamma Functions
- Study Legendre Polynomials
- Discus about Bessels Functions and its applications
- do study of Eulerian Integral

**Unit I:The Gamma & Beta Functions**:

The Gamma and Beta integrals, Functions and their properties, The Euler Reflection formula, Riemann Zeta functions, Gauss's multiplication formula for G(mx), Integral representation for Log G(mx), The Bohr-Mollerup theorem. [15 lectures]

**Unit II: Legendre Polynomials:**

Solution of Legendre differential equation and Legendre polynomials, Rodrigue's formula, Generating function, Recurrence relations, Orthogonal and orthonormal functions, Orthogonal property of Legendre's polynomials, Fourier Legendre's series. [15 lectures]

**Unit III: Bessel's Functions:**

Solution of Bessel's differential equation and Bessel's functions, Bessel's function of first kind and second kind, Orthogonality of Bessel's functions, Fourier Bessel's series.

[15 lectures]

**Unit IV: The Hypergeometric Functions:**

The Hypergeometric series, Euler's Integral Representation, the Hypergeometric equation, the Barnes Integral for the Hypergeometric function. [15 lectures]

**Recommended Text Books:**

1. **George E. Andrews**, Richard Askey, Ranjana Roy, Special Functions, Cambridge University Press, (2010).

2. **R. K. Jain and S. R. K. Iyengar** "Advanced Engineering Mathematics" Narosa Publishing House, New Delhi, (2008).

3. **Mark A. Pinsky,** "Partial Differential Equations and Boundary Value Problem with Applications" McGraw-Hill, Ins. (1991).

**Reference Books:**

1. **Earl D. Rainville,** "Special Functions" Chelsea Publishing Company, New York, (1960).

2. **H. M. Srivastava,** "A Treatise On Generating Functions" John Wiley & Sons, New York.

3. **N N Lebedev,** "Special Functions and their applications" Dover Publications (1965)

**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"