**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce, and Science College, Ahmednagar (Autonomous)

**(Affiliated to Savitribai Phule Pune University, Pune)**

# National Education Policy (NEP)
# Choice Based Credit System (CBCS)

## Programme Skeleton and Syllabus of
## M.Sc. Mathematics (Major)

**Implemented from**

# Academic Year 2023-24

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce, and Science College, Ahmednagar (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

# National Education Policy (NEP)
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## Programme Skeleton and Syllabus of
## M.Sc. Mathematics

**Implemented from**

# Academic Year 2023-24

## 9.2 Distribution of credits

| Type of Courses | Total Credits | Credits/ Semester |
|---|---|---|
| Discipline-Specific Core Courses (DSC) | 54 | 14 /12 |
| Discipline Specific Elective Courses (DSE) | 16 | 04 |
| Research Methodology (RM) | 04 | Semester I only |
| On-Job Training/ Internship (OJT/I | 04 | Semester II only |
| Project (PR) | 10 | Semesters III and IV only |
| Total | 88 | 22 |

## 9.3 Master of Science (M.Sc.) Course Distribution

| Class | Semester | Subjects | Courses | DSC | | DSE | | RM/OJT/ Internship etc. | | Project* | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | T | P | T | P | T | P | | |
| M. Sc. I | I | 01 | 09 | 03 | 03 | 01 | 01 | 01* | | 00 | 22 |
| M. Sc. I | II | 01 | 09 | 03 | 03 | 01 | 01 | 00 | 01 | 00 | 22 |
| M. Sc. II | III | 01 | 07 | 02 | 02 | 01 | 01 | 00 | 00 | 01 | 22 |
| M. Sc. II | IV | 01 | 07 | 02 | 02 | 01 | 01 | 00 | 00 | 01 | 22 |

* RM: Theory and Practical credits in RM paper shall be decided by the Department. The final marks/grade point shall be calculated by considering theory and practical marks.

## 9.4 Master of Science (M. Sc.) Credit Distribution

| Class | Semester | Subjects | Courses | DSC | | DSE | | RM/OJT / Internship etc. | | Project * | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | T | P | T | P | T | P | | |
| M. Sc. I | I | 01 | 09 | 08 | 06 | 02 | 02 | 04* | | 00 | 22 |
| M. Sc. I | II | 01 | 09 | 08 | 06 | 02 | 02 | 00 | 04 | 00 | 22 |
| **Exit Option: PG Diploma** | | | | | | | | | | | |
| M. Sc. II | III | 01 | 07 | 08 | 06 | 02 | 02 | 00 | 00 | 04 | 22 |
| M. Sc. II | IV | 01 | 07 | 08 | 04 | 02 | 02 | 00 | 00 | 06 | 22 |
| | | | | **32** | **20** | **08** | **08** | **02** | **06** | **12** | **88** |

## 9.5 Master of Science (M. Sc.) Distribution of Courses

| Class | Semester | Course and their credits in the bracket | | | |
|---|---|---|---|---|---|
| | | DSC | DSE | RM/OJT/ Internship etc. | Project * |
| M. Sc. I | I | DSC -01 (03) | DSE -01 (02) | RM-01(04) | NA |
| M. Sc. I | I | DSC -02 (03) | DSE -02 (02) | | |
| M. Sc. I | I | DSC -03 (02) | | | |
| M. Sc. I | I | DSC -04 (02) | | | |
| M. Sc. I | I | DSC -05 (02) | | | |
| M. Sc. I | I | DSC -06 (02) | | | |
| M. Sc. I | II | DSC -07 (03) | DSE -03 (02) | OJT-01 (04) | NA |
| M. Sc. I | II | DSC -08 (03) | DSE -04 (02) | | |
| M. Sc. I | II | DSC -09 (02) | | | |
| M. Sc. I | II | DSC -10 (02) | | | |
| M. Sc. I | II | DSC -11 (02) | | | |
| M. Sc. I | II | DSC -12 (02) | | | |
| M. Sc. II | III | DSC -13 (04) | DSE -05 (02) | NA | PR-01(04) |
| M. Sc. II | III | DSC -14 (04) | DSE -06 (02) | | |
| M. Sc. II | III | DSC -15 (03) | | | |
| M. Sc. II | III | DSC -16 (03) | | | |
| M. Sc. II | IV | DSC -17 (04) | DSE -05 (02) | NA | PR-02(06) |
| M. Sc. II | IV | DSC -18(04) | DSE -06 (02) | | |
| M. Sc. II | IV | DSC -19 (02) | | | |
| M. Sc. II | IV | DSC -20 (02) | | | |

### Programme Framework (Courses and Credits): M. Sc. Mathematics

| Sr. No. | Year | Semester | Level | Course Type | Course Code | Title | Credits |
|---|---|---|---|---|---|---|---|
| **1.** | I | I | 6.0 | DSC-01 | MS-MT111T | Linear Algebra | 03 |
| **2.** | I | I | 6.0 | DSC-02 | MS-MT112T | Real Analysis | 03 |
| **3.** | I | I | 6.0 | DSC-03 | MS-MT113T | Group Theory | 02 |
| **4.** | I | I | 6.0 | DSC-04 | MS-MT114P | Multivariable Calculus | 02 |
| **5.** | I | I | 6.0 | DSC-05 | MS-MT115P | Advanced Calculus | 02 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **6.** | I | I | 6.0 | DSC-06 | MS-MT116P | Lab for Numerical Linear Algebra | 02 |
| **7.** | I | I | 6.0 | DSE-01 | MS-MT117T | Ordinary Differential Equations | 02 |
| **8.** | I | I | 6.0 | DSE-02 | MS-MT118P | Advanced LaTeX | 02 |
| **9.** | I | I | 6.0 | RM-01 | MS-MT119T/P | Research Methodology and Computer Applications | 04 |
| **10.** | I | II | 6.0 | DSC-07 | MS-MT121T | Topology | 03 |
| **11.** | I | II | 6.0 | DSC-08 | MS-MT122T | Advanced Complex Analysis | 03 |
| **12.** | I | II | 6.0 | DSC-09 | MS-MT123T | Ring Theory | 02 |
| **13.** | I | II | 6.0 | DSC-10 | MS-MT124P | Advanced Numerical Analysis | 02 |
| **14.** | I | II | 6.0 | DSC-11 | MS-MT125P | Advanced Operations Research | 02 |
| **15.** | I | II | 6.0 | DSC-12 | MS-MT126P | Mathematical Statistics | 02 |
| **16.** | I | II | 6.0 | DSE-05 | MS-MT127T | Partial Differential Equations | 02 |
| **17.** | I | II | 6.0 | DSE-06 | MS-MT128P | Combinatorics | 02 |
| **18.** | I | II | 6.0 | OJT-01 | MS-MT129P | Programming Language | 04 |
| **19.** | II | III | 6.5 | DSC-13 | MS-MT131T | Functional Analysis | 04 |
| **20.** | II | III | 6.5 | DSC-14 | MS-MT132T | Field Theory | 04 |
| **21.** | II | III | 6.5 | DSC-15 | MS-MT133P | Mathematics and Python Programming | 03 |
| **22.** | II | III | 6.5 | DSC-16 | MS-MT134P | Graph Theory | 03 |
| **23.** | II | III | 6.5 | DSE-05 | MS-MT135T | Classical Mechanics | 02 |
| **24.** | II | III | 6.5 | DSE-06 | MS-MT136P | Fractional Calculus | 02 |
| **25.** | II | III | 6.5 | PR-01 | MS-MT137P | Project-I | 04 |
| **26.** | II | IV | 6.5 | DSC-17 | MS-MT131T | Number Theory | 04 |
| **27.** | II | IV | 6.5 | DSC-18 | MS-MT132T | Differential Geometry | 04 |
| **28.** | II | IV | 6.5 | DSC-19 | MS-MT133P | Introduction to Data Science | 02 |
| **29.** | II | IV | 6.5 | DSC-20 | MS-MT134P | Mathematica Wolfram (Cloud) | 02 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **30.** | II | IV | 6.5 | DSE-07 | MS-MT135T | Fourier Series and Boundary Value Problems | 02 |
| **31.** | II | IV | 6.5 | DSE-08 | MS-MT136P | MATLAB | 02 |
| **32.** | II | IV | 6.5 | PR-02 | MS-MT137P | Project-II | 06 |

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce, and Science College, Ahmednagar (Autonomous)

## Board of Studies in Mathematics

| Sr. No. | Name | Designation |
|---|---|---|
| 1. | Dr. S. B. Gaikwad | Chairman |
| 2. | Dr. S. V. Ingale | Member |
| 3. | Mr. S. A. Tarate | Member |
| 4. | Mr. K. A. Kshirsagar | Member |
| 5. | Ms. B. N. Todkari | Member |
| 6. | Ms. D. G. Gade | Member |
| 7. | Mr. A. S. Jadhav | Member |
| 8. | Ms. P. D. Kasule | Member |
| 9. | Ms. P. S. Ansari | Member |
| 10. | Mr. R. V. Sharma | Member |
| 11. | Mr. T. A. Bhakare | Member |
| 12. | Mr. H. N. Shaikh | Member |
| 13. | Dr. A. A. Kulkarni | Member |
| 14. | Prof. (Dr). A. V. Mancharkar | Member |
| 15. | Dr. N. S. Darkunde | Academic Council Nominee |
| 16. | Dr. S. B. Bhalekar | Academic Council Nominee |
| 17. | Dr. G. S. Kadu | Vice-Chancellor Nominee |
| 18. | Mr. P. L. Pawar | Alumni |
| 19. | Mr. Shirish Padalkar | Industry Expert |

## 1. Prologue/ Introduction of the program: At least one page

Welcome to the M.Sc. Mathematics program! This program is designed for students who have a deep passion for mathematics and wish to pursue advanced studies in this fascinating field. Through this prologue, let's explore the essence and significance of this program. The M.Sc. Mathematics program offers an in-depth exploration of various branches of mathematics, providing students with a comprehensive understanding of advanced mathematical theories, techniques, and applications. It is designed to build upon the foundational knowledge acquired during the undergraduate studies and propel students towards advanced topics and cutting-edge research in mathematics.

During the course of this program, students will engage with complex mathematical concepts, explore abstract mathematical structures, and delve into the depths of mathematical analysis, algebra, geometry, number theory, topology, and other specialized areas. They will have the opportunity to deepen their understanding of the underlying principles of mathematics and develop expertise in their chosen areas of specialization. The program emphasizes rigorous mathematical thinking, logical reasoning, and problem-solving abilities. Students will be exposed to advanced mathematical proofs, challenging problem sets, and mathematical modeling exercises, which will enable them to develop the analytical skills necessary to tackle complex mathematical problems and make original contributions to the field. Through seminars, discussions, and interactions with faculty members and fellow students, the M.Sc. Mathematics program fosters an environment of intellectual curiosity, creativity, and collaboration. Students will have the opportunity to engage in scholarly debates, exchange ideas, and explore the frontiers of mathematical research. Research plays a crucial role in the M.Sc. Mathematics program. Students will have the chance to undertake independent research projects under the guidance of experienced faculty members. This research component allows students to explore their interests, contribute to the advancement of mathematical knowledge, and develop the skills required for advanced research in mathematics.

The program also emphasizes the use of advanced mathematical software, computational tools, and programming languages to aid in mathematical analysis, simulation, and modeling. Students will gain proficiency in utilizing technology to enhance their understanding, perform numerical experiments, and visualize mathematical concepts.Upon completion of the program, graduates will possess a deep and comprehensive knowledge of advanced mathematics, advanced problem-solving skills, and the ability to conduct rigorous mathematical research. They will be well-prepared for a range of career options, including pursuing doctoral studies, academic positions, research and development roles in industries, government organizations, and other sectors that require strong mathematical expertise. The M.Sc. Mathematics program aims to nurture the next generation of mathematicians, researchers, educators, and problem solvers. It offers a challenging and intellectually stimulating academic journey that not only expands the boundaries of mathematical knowledge but also cultivates critical thinking, logical reasoning, and the ability to communicate mathematical ideas effectively.

2**. Programme Outcomes (POs)**

1. Students will deepen their understanding of advanced mathematical theories, techniques, and concepts across various branches of mathematics.

2. Students will enhance their logical thinking and apply advanced mathematical concepts to solve complex problems.

3. Students will learn to formulate research questions, design experiments or investigations, collect and analyze data, and present their findings in a clear and coherent manner.

4. Students will learn to apply advanced mathematical techniques and tools to analyze and solve challenging problems encountered in mathematics and related fields.

5. Students will learn to formulate mathematical models that represent real-world phenomena, analyze the models using mathematical methods, and interpret the results to make informed decisions or predictions.

6. Students will develop proficiency in utilizing computational tools, software, and programming languages to aid in mathematical analysis, numerical simulations, and data visualization.

7. Students will learn to present complex mathematical concepts, proofs, and research findings to both technical and non-technical audiences.

8. The program fosters a collaborative learning environment, where students will engage in teamwork, participate in group projects, and actively contribute to discussions and seminars.

9. Students will develop a strong foundation for professional growth and lifelong learning in mathematics.

**Ahmednagar Jhilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics

| Title of the Course: Linear Algebra | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: I | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-1 | MS-MT111T | 03 | 00 | 03 | 45 | 30 | 70 | 100 |

**Learning Objectives:**

1. To study Basis and Dimension of Vector Spaces.
2. Learn properties of linear transformation and matrix.
3. Obtain orthonormal basis using Gram - Schmidt orthogonalisation.
4. Find canonical form, rational form and triangular form of matrix.

**Course Outcomes (Cos):**

1. Find basis and dimension of vector space.
2. Find matrix of linear transformation.
3. Reduce matrix to triangular form and Jordan canonical form.
4. Find Invariant Subspace.
5. Solving system of linear equations.

**Detailed Syllabus:**

Unit I: Vector Spaces (14 Hours)

1.1 Definition and examples.
1.2 Subspaces.
1.3 Basis and Dimension.
1.4 Row equivalence of matrices.
1.5 Systems of linear equations.
1.6 Systems of homogeneous equations.

Unit II: Vector Spaces with an Inner Product (10 Hours)

2.1 Introduction.
2.2 The concept of symmetry.
2.3 Inner products.
2.4 Orthogonal and orthonormal sets.
2.5 Gram-Schmidt orthogonalisation process.

Unit III: Linear Transformation and Matrices (09 Hours)

3.1 Introduction.
3.2 Linear Transformations.
3.3 Addition and Multiplication of Matrices.
3.4 Linear transformation and matrices.

Unit IV: The Theory of a Single Linear Transformation (12 Hours)

4.1 Basic Properties.
4.2 Invariant subspaces
4.3 The Triangular Form Theorem.

4.4 The Jordan Canonical Form.

**Suggested Readings:**

1**.** Charles W Curtis: Linear Algebra an Introductory Approach, Springer.

2. Vivek Sahai, Vikas Bist – Linear Algebra, Narosa Publication.

3. P. B. Bhattacharya, S.R. Nagpaul, S.K. Jain – First course In Linear Algebra, Second Edition, New Age International Publishers.

4. K. Hoffman, Ray Kunze – Linear Algebra, Prentice Hall of India Private Ltd.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar
# (Autonomous)
# Syllabus
# M.Sc. Mathematics

| Title of the Course: Real Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: I | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-02 | MS-MT112T | 03 | 00 | 03 | 45 | 30 | 70 | 100 |

**Learning Objectives:**

1. To develop a fundamental tool for carrying out integration that behaves well with taking limits, and admitting a vast class of functions for which Riemann's integration theory is not applicable.
2. To generalize the concept of integration using measures.
3. To develop familiarity with measures, Lebesgue integration, differentiation and convergence.
4. To introduce the concepts of measure and integral with respect to a measure, to show their basic properties, and to provide a basis for further studies in Mathematical Analysis, Probability Measure Theory and Dynamical Systems.

**Course Outcomes (Cos):**

1. Extend their knowledge of Lebesgue theory of integration by selecting and applying its tools for further research in this and other related areas.
2. To study the concept of integrability of real-valued functions over the closed and bounded interval and their applications in different areas, such as quantum physics.
3. Apply the theorems of monotone and dominated convergence and Fatou's lemma.
4. To recognize function of bounded variation, total variation and applications of fundamental theorem of calculus

Details of Syllabus:

Unit I: Lebesgue Measure (17 Hours)

1.1 Lebesgue Outer Measure.
1.2 σ- algebra of Lebesgue Measurable Sets.
1.3 Outer and Inner Approximation of Lebesgue Measurable Sets.
1.4 Countable Additivity.
1.5 Continuity.
1.6 Borel-Cantelli Lemma.
1.7 Non-measurable Set, Cantor Set, Cantor-Lebesgue Function.

Unit II: Lebesgue Measurable Functions (12 Hours)

2.1 Definition and algebra of Lebesgue Measurable Functions.
2.2 Sequential Pointwise Limits and Approximations by Simple Functions.
2.3 Littlewood's Three Principles.

Unit III: Differentiation (10 Hours)

3.1 Continuity of Monotone Functions.
3.2 Lebesgue's Differentiation Theorem.
3.3 Functions of Bounded Variation.
3.4 Absolutely Continuous Functions.

Unit IV: Integration (05 Hours)

4.1 Introduction.
4.2 Integration of Derivatives.
4.3 Differentiation of Indefinite Integral.
4.4 Fundamental Theorem of Calculus.

**Suggested Readings :**

1. H. L. Royden, Patrick Fitzpatrick, Real Analysis, Fourth Edition, Prentice Hall, 2010.
2. Elias M. Stein, Rami Shakarchi, Real Analysis, Princeton University Press, 2005.
3. Anthony W. Knapp, Basic Real Analysis, Springer Science & Business Media, 2005.
4. Karen Saxe, Beginning Functional Analysis (Springer International Edition), 2001.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar
# (Autonomous)
# Syllabus
# M.Sc. Mathematics (Major)

| Title of the Course: Group Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: I | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-03 | MSC-MT 113 T | 02 | 00 | 02 | 30 | 15 | 35 | 50 |

**Learning Objectives:**

1. Understand and use the properties of group actions.
2. Understand use the properties of and manipulate permutations.
3. The course will develop an in-depth understanding of one of the most important branch of the abstract algebra with applications to practical real-world problems.
4. The group theory is the branch of abstract-algebra that is incurred for studying and manipulating abstract concepts involving symmetry.

**Course Outcomes (Cos):**

1. Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
2. The significance of the notion of cosets, normal subgroups, and factor groups.
3. Decide whether a given group is cyclic, and given a finite cyclic group, find a generator for a subgroup of a given order.
4. Use of Group Theory in solving problems of Mathematics such as Algebraic topology, how Group Theory explains symmetry and hence have application in Physics, chemistry and other subjects.

**Detailed Syllabus:**

Unit I: Introduction to Groups (06 Hours)

1.1 Definition of Groups and Subgroups.
1.2 Order of finite group; Order of an element in group.
1.3 Cyclic Groups.
1.4 Permutations Groups, Isomorphism of Group and Automorphisms.

Unit II: Cosets (06 Hours)

2.1 Introduction.
2.2 Stabilizer and Orbit.
2.3 External Direct Product.
2.4 Properties of External Direct Product.

Unit III: Normal Subgroups and Homomorphisms (08 Hours)

3.1 Normal Subgroups.
3.2 Factor Groups; Application of Factor Groups.
3.3 Internal Direct Products.
3.4 Group Homomorphism; Definition and examples; Properties of Homomorphism.

3.5 First Isomorphism.

Unit IV: Sylow Theorems (10 Hours)

4.1 Fundamental Theorem of Finite Abelian Groups.
4.2 Isomorphism Classes of Abelian Groups; Proof of the Fundamental Theorem.
4.3 Conjugacy Classes; Class Equation.
4.4 The Sylow's Theorems; Applications of Sylow's Theorems.

**Suggested Readings :**


1. Joseph Gallian, Contemporary Abstract Algebra, 8th Edition, Cengage Learning India Pvt. Ltd. ISBN-10 9353502527.
2. M. Artin, Algebra, Prentice Hall, 2011.
3. N. S. Gopalkrishnan, University Algebra, Wiley Eastern Ltd, 1986.
4. J. B. Fraleigh, A First Course in Abstract Algebra, 7th Edition, Pearson Edition Ltd, 2002.
5. S. Luthar, I. B. S. Passi, Algebra (Vol 1), Groups; Narosa Publication House, 2009.
6. N. Herstein, Topics in Algebra, Wiley Eastern Ltd, 2nd Edition, 1975.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics

| Title of the Course: Multivariable Calculus | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: I | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-04 | MS-MT114P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

**Learning Objectives:**

1. Learn the concepts of limit and continuity and their application in the context of scalar and vector fields.
2. Understand the concept of total derivatives and learn to calculate the gradient of a scalar field.
3. Develop an understanding of paths and line integrals.
   Learn the first and second fundamental theorems of calculus for line integrals and understand their significance.

**Course Outcomes (Cos)**

1. Develop a solid understanding of differential calculus of scalar and vector fields, including limits, continuity, derivatives, and partial derivatives.
2. Demonstrate proficiency in calculating directional derivatives and understanding their significance in differentiating scalar and vector fields.
3. Understand the implications of the Inverse Function theorem and Implicit Function theorems in differential calculus.
4. Understand the concept of work as a line integral and solve problems related to line integrals with respect to arc length.
5. Demonstrate proficiency in analyzing open connected sets and understanding their relevance in line integrals.

**Detailed Syllabus:**

UNIT-I: Differential Calculus of Scalar and Vector Fields- I (15 Hours)

**1.1** Functions from $R^n$ to $R^m$, scaler and vector fields.
**1.2** Limit and continuity.
**1.3** The derivative of a scalar field with respect to a vector;
**1.4** Directional derivatives and partial derivatives; Partial derivatives of higher order; Inverse function theorem and Implicit Function theorem (Without proof).

UNIT-I: Differential Calculus of Scalar and Vector Fields- II (15 Hours)

**2.1** Directional derivatives and continuity
**2.2** The total derivatives; the gradient of a scalar field;
**2.3** A sufficient condition for differentiability.
**2.4** A chain rule for derivatives of scalar fields; Applications to geometry. Level sets. Tangent planes; Derivatives of vector fields; Differentiability implies continuity; the chain rule for derivatives of vector fields.

UNIT-III: Line Integrals-I (15 Hours )

**3.1** Paths and line integrals.
**3.2** Other notations for line integrals; Basic properties of line integrals.
**3.3** The concept of work as a line integral.
**3.4** Line integrals with respect to arc length; further applications of line integrals.

UNIT-IV: Line Integrals-II (15 Hours )

**4.1** Open connected sets.
**4.2** Independence of the path.
**4.3** The first and second fundamental theorem of calculus for line integrals;
**4.4** Necessary and sufficient conditions for a vector field to be a gradient; Necessary conditions for a vector field to be a gradient.

**Suggested Readings:**

1. Tom M. Apostol, Calculus Volume II (Second Edition) Indian Reprint 2016 (John Wiley & Sons, Inc) ISBN:978-81-265-1520-2.

2. Gerald B. Folland, Advanced Calculus, Pearson Edn 2012.

3. A Devinatz, Advanced calculus (Holt, Reinhart & Winston) 1968.

4.. W. Rudin: Principles of Mathematical Analysis (Mc-Graw Hill).

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics

| Title of the Course: Advanced Calculus | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | Semester: I | | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-05 | MS-MT115P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

**Learning Objectives:**

1. Learn to calculate the double integral of a step function and understand the definition of the double integral for a function defined and bounded on a rectangle.
2. Gain knowledge of Green's theorem in the plane and understand its applications. Explore the necessary and sufficient condition for a two-dimensional vector field to be a gradient.
3. Understand the parametric representation of a surface and learn the concept of the fundamental vector product.
4. Study the Stokes' theorem, divergence theorem (Gauss' theorem) and its applications. Apply the divergence theorem to solve problems involving vector fields.

**Course Outcomes (Cos)**

1. Gain proficiency in evaluating double integrals and apply the technique of repeated one-dimensional integration.
2. Understand the integrability of continuous and bounded functions with discontinuities and extend the concept of double integrals to more general regions.
3. Acquire proficiency in applying Green's theorem in the plane and understanding its applications.
4. Develop skills in changing variables in a double integral and applying the transformation formula.
5. Gain proficiency in applying Stokes' theorem, divergence theorem and understanding its implications.

**Detailed Syllabus:**

UNIT-I: Multiple Integrals -I (15 Hours )

**1.1** Partitions of rectangles, Step functions.

**1.2** The double integral of a step function; The definition of the double integral of a function defined and bounded on a rectangle.

**1.3** Upper and lower double integrals; Evaluation of double integral by repeated one-dimensional integration.

**1.4** Geometric interpretation of the double integral as a volume; Worked examples.

**1.5** Inerrability of continuous functions; Inerrability of bounded functions with discontinuities; double integrals extended over more general regions; Applications to area and volume; Worked examples.

UNIT-II: Multiple Integrals -II (15 Hours )

- **2.1** Green's theorem in the plane; some applications of green's theorem;
- **2.2** A necessary and sufficient condition for a two-dimensional vector field to be a gradient.
- **2.3** Change of variables in a double integral; Special cases of the transformation formula (without proof),
- **2.4** General case of the transformation formula (without Proof) Extensions to higher dimensions; Change of variables in an n-fold integral; Worked examples.

UNIT-III: Surface Integrals-I (15 Hours)

- **3.1** Parametric representation of a surface.
- **3.2** The fundamental vector product; The fundamental vector products a normal to the surface; Area of a parametric surface.
- **3.3** Surface integrals; Change of parametric representation.
- **3.4** Other notations for surface integrals.

UNIT-IV: Surface Integrals-II (15 Hours)

- **4.1** The theorem of Stokes.
- **4.2** Curl and divergence of a vector field.
- **4.3** Properties of curl and divergence.
- **4.4** The divergence theorem (Gauss' theorem) and applications of divergence theorem.

**Suggested Readings:**

1. Tom M. Apostol, Calculus Volume II (Second Edition) Indian Reprint 2016 (John Wiley & Sons, Inc) ISBN:978-81-265-1520-2.

2. Gerald B. Folland, Advanced Calculus, Pearson Edn 2012.

3. A Devinatz, Advanced calculus (Holt, Reinhart & Winston) 1968.

4.. W. Rudin: Principles of Mathematical Analysis (Mc-Graw Hill).

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar
# (Autonomous)
# Syllabus
# M.Sc. Mathematics

| **Title of the Course: Lab for Numerical Linear Algebra** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year: I** | | | | **Semester: I** | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-06 | MS-MT116P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

**Learning Objectives:**

1. Understand the theoretical foundations of numerical linear algebra algorithms.
2. Gain proficiency in using mathematical software for solving linear algebra problems.
3. Implement and analyze numerical methods for solving linear systems, eigenvalue problems, and least squares approximation.
4. Apply numerical linear algebra techniques to real-world problems.
5. Develop critical thinking and problem-solving skills through practical programming exercises.

**Course Outcomes (Cos):**

1. Understand the fundamental concepts and techniques of numerical linear algebra and apply mathematical software to perform vector and matrix computations.
2. Solve linear systems of equations using direct and iterative methods.
3. Compute eigenvalues and eigenvectors of matrices and understand their significance in various applications and perform matrix factorizations and understand their computational implications.
4. Implement and analyze numerical algorithms for solving optimization problems.
5. Apply numerical linear algebra techniques to machine learning tasks.

**Detailed Syllabus:**

Unit I: Introduction to Mathematical Software. (10 Hours)

1.1 Introduction to the mathematical software package.
1.2 Familiarization with the software interface, basic syntax, and commands.
1.3 Working with vectors, matrices.
1.4 Basic linear algebra operations.

Unit II: Solving Linear Systems (15 Hours)

2.1 Direct methods: Gaussian elimination, LU decomposition, and Cholesky factorization.
2.2 Iterative methods: Jacobi, Gauss-Seidel, and Conjugate Gradient methods.
2.3 Analysis of numerical stability, convergence, and computational complexity.
2.4 Implementation of algorithms using mathematical software.

Unit III: Eigenvalue Problems (20 Hours)

3.1 Power iteration method for computing dominant eigenvalues and eigenvectors.
3.2 QR algorithm for computing all eigenvalues of a matrix.
3.3 Implementation and analysis of eigenvalue algorithms using mathematical software.

Unit IV: Applications (15 Hours)

4.1 Sparse matrix computations.
4.2 Least Squares Approximation.
4.3 Numerical methods for singular value decomposition (SVD).

**Suggested Readings :**

1. Lloyd N. Trefethen and David Bau III, Numerical Linear Algebra, Society for Industrial and Applied Mathematics; Illustrated edition (1 June 1997).

2. James W. Demmel, Applied Numerical Linear Algebra, SIAM; 1st edition (August 1, 1997).

3. Gene H. Golub, Charles F. Van Loan, Matrix Computations, Johns Hopkins University Press; fourth edition, 2013.

4. Philip E. Gill, Walter Murray, Margaret H. Wright, Numerical Linear Algebra and Optimization, reprint, SIAM, 2021.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar
# (Autonomous)
# Syllabus
# M.Sc. Mathematics

| Title of the Course: Ordinary Differential Equations | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | Semester: I | | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSE-1 | MS-MT117T | 02 | 00 | 02 | 30 | 15 | 35 | 50 |

**Learning Objectives:**

1. Learn existence theory of linear differential equations.
2. Learn the solutions of Differential equations using various methods.
3. Develop problem solving approach for various differential equations.
4. Understand applications of ODE in all sciences.

**Course Outcomes (Cos):**

1. Find general solutions of homogeneous and non-homogeneous differential equations.
2. Find solutions of differential equations using power series.
3. Find solutions of linear differential equations using different methods.
4. Understand the method of successive approximations.

**Detailed Syllabus:**

Unit I: Linear equations of the first order (06 Hours)

1.1 Linear equations of the first order.
1.2 The equation y'+ay=0.
1.3 The equation y'+ay=b(x).
1.4 The general linear equations of first order.

Unit II: Second order linear equations (12 Hours)

2.1 The general solution of the homogeneous equations.
2.2 Use of a known solution to find another solution.
2.3 Homogeneous equations with constant coefficients.
2.4 The method of undetermined coefficient.
2.5 The method of variation of parameters.

Unit III: Power Series solutions (06 Hours)

3.1 Review of power series.
3.2 Series solutions of first order equations.
3.3 Second order linear equations.
3.4 Ordinary points, Regular singular points.

Unit IV: Existence and uniqueness of solutions to first order equations (06 Hours)

4.1 Equations with variables separated.
4.2 Exact equations.
4.3 Method of successive approximations.

4.4 Lipschitz condition.

**Suggested Readings:**

1. G.F. Simmons : Differential equations with applications and Historical Notes second edition (Mc-Graw Hill).
2. A. Coddington, An Introduction to Ordinary Differential Equations (Prentice-Hall, 1961).
3. G. Birkhoff and G.C. Rota: Ordinary differential equations, (John Wiley and Sons), Fourth Edition.
4. S. G. Deo, V. Lakshmikantham, V. Raghvendra, textbook of Ordinary Differential Equations, second edition, Tata Mc-Graw Hill, 2015.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar
# (Autonomous)
# Syllabus
# M.Sc. Mathematics

| Title of the Course: Advanced LaTeX | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: I | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSE-02 | MS-MT118P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

**Learning Objectives:**

1. Develop advanced skills in document design and formatting using LaTeX.
2. Learn advanced techniques for typesetting complex mathematical symbols, equations, matrices, vectors, theorem environments, and mathematical proofs.
3. Gain expertise in managing bibliographic references and creating bibliographies using LaTeX's bibliography management system (BibTeX or biblatex).
4. Learn how to create and modify custom styles and packages, including defining new environments, commands, and macros.

**Course Outcomes (Cos)**

1. Typeset mathematical formulas, use nested list, tabular & array environments.
2. Create or import graphics.
3. Use alignment command and multiline formulas, bibliography and citation, making index and glossary.
4. Use a beamer to create presentations and typeset mathematical Projects.
5. Create your own template for Dissertation, Thesis and Books.

**Detailed Syllabus:**

Unit I: MikTex Engine with editor (10 Hours)

1.1 Preparing an input file, sentences and paragraphs.
1.2 The document class, sectioning, display material.
1.3 Running Latex, changing the type style.
1.4 Producing mathematical symbols and mathematical formulae.
1.5 arrays, delimiters, multiline formulae.
1.6 Putting one thing on other, spacing in math mode.

Unit II: Formatting Text and design (20 Hours)

2.1 Design it yourself: document class, page style, title page.
2.2 Customizing the style, line and page breaking.
2.3 Numbering, length, spaces and boxes.
2.4 Formatting with boxes, centring and flushing.
2.5 List making environments.
2.6 Changing font type size and special symbols.

2.7 Picture, picture environments, picture objects.
2.8 Text, boxes, straight lines, arrow, stacks, circles, oval, framing.
2.9 Curve, grid, repeat patterns.

Unit III: Macros and bibliography (15 Hours)

3.1 Defining command and environments.
3.2 Producing and including graphics in a Latex file.
3.3 Figures and other floating bodies.
3.4 Lining it up in columns, table of content.
3.5 Cross-reference, bibliography and citation.
3.6 Making index and glossary, slides, overlays and notes, letters.

Unit IV: Beamer and mathjax (15 Hours)

4.1 Making presentation slides in beamer class Latex.
4.2 Various styles in beamer presentation, dynamic slides.
4.3 Postscript macros for generic tex (pstrix): arguments.
4.4 Dimension, coordinates, angles, line styles, fill styles.
4.5 Custom styles, custom graphics, picture tools.
4.6 Text tricks, node and connection special tricks.
4.7 Basics of mathjax, mathjax configuration options.

**Suggested Readings :**

1. Kottwitz, S. LaTeX Beginner's Guide. Packt Publishing Ltd., UK, 2011.
2. Leslie L. A Document Preparation System User's Guide and Reference Manual, Addison-Wesley Publishing Company, 2001.
3. Tantau,T. User Guide to the Beamer Class, http://latex-beamer.sourceforge.net.
4. Oetiker,T. The Not So Short Introduction to LATEX2E, https://tobi.oetiker.ch/lshort/lshort.pdf

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics

| Title of the Course: Research Methodology and Computer Applications | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: I | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| RM-1 | MS-MT119T/P | 02 | 02 | 04 | 90 | 30 | 70 | 100 |

**Learning Objectives:**

1. Develop an understanding of various research methods and techniques used in mathematical research.
2. Learn how to search and retrieve relevant research papers, books, and scholarly resources using databases and online platforms.
3. Learn programming languages commonly used in mathematics, such as Python or MATLAB, and explore numerical methods for solving mathematical problems.
4. Learn how to effectively communicate mathematical ideas, concepts, and results through oral presentations, technical reports, and academic writing.

**Course Outcomes (Cos)**

1. Design a good quantitative purpose statement and good quantitative research questions and hypotheses.
2. Explain the epistemological assumptions of qualitative research methods, how to select the appropriate qualitative research method to address a research question, and the criteria for evaluating qualitative research methods.
3. Design and conduct an in-depth interview study, an oral history interview study, a focus group study, an ethnography, a qualitative content analysis study, a qualitative case study, and a mixed-method study.
4. Write a qualitative methods and findings section, as for a qualitative research article.
5. Design a good qualitative purpose statement and a good central question.

**Detailed Syllabus:**

Unit I: Introduction to Research Methods (20 Hours)

1.1 Formulation of objectives.
1.2 Formulation of Hypotheses, Types of Hypotheses.
1.3 Methods of testing Hypotheses.
1.4 Research Plan and its Components.
1.5 Methods of Research (Survey, Observation, case study, experimental, historical and comparative methods).

Unit II: Research: a way of Thinking (20 Hours)

2.1 Scientific research and literature survey.

2.2 History of mathematics.
2.3 Finding and solving research problems.
2.4 Role of a supervisor.
2.5 A survey of a research topic.
2.6 Publishing a paper, reviewing a paper.
2.7 Research grant proposal writing.
2.8 Copyright issues, ethics and plagiarism.

Unit III: Research Tools (25 Hours)

3.1 Searching google (query modifiers).
3.2 MathSciNet, ZMATH.
3.3 Scopus, ISI Web of Science.
3.4 Impact factor, h-index.
3.5 Google Scholar, ORCID, JStor.
3.6 Online and open access journals.
3.7 Virtual library of various countries.

Unit IV: The Computer-Its Role in Research (25 Hours)

4.1 Internet, Web Browsers, Search Engines.
4.2 MS Word: Handling graphics tables and charts.
4.3 Formatting in MS-Word.
4.4 MS PowerPoint: Creating Slide Show, Screen Layout and Views, Applying Design Template.
4.5 MS Excel: Features, Formulas and Functions, Data Analysis and Data Visualization in Excel.
4.6 software for Mathematics: Mathematica /MATLAB /Scilab/GAP.

**Suggested Readings :**

1. Kumar. R: Research Methodology: A Step-by-Step Guide for Beginners, (3rd Edition), SAGE, Inc., 2011.
2. Kothari C.R, Research Methodology methods, and techniques, second revised edition
3. Dr. Prabhat Pandey, Dr. Meenu Mishra Pandey, RESEARCH METHODOLOGY: TOOLS AND TECHNIQUES, 1st EDITON, BRIDGE CENTER, 2015
4. Nicholas J. Hingham, Handbook of Writing for the Mathematical Sciences, Second Edition, SIAM, 1998.
5. Norman E. Steenrod, Paul R. Halmos, Menahem M. Schiffer, Jean A. How to Write Mathematics, American Mathematical Society, 1973.
6. Shortis. Tim: The Language of ICT: Information and Communication Technology, Taylor & Francis, 2016.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar
## (Autonomous)
## Syllabus
## M.Sc. Mathematics (Major)

| Title of the Course: Topology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | Semester: II | | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-07 | MS-MT121T | 03 | 00 | 03 | 45 | 30 | 70 | 100 |

**Learning Objectives:**

1. To introduce the student to elementary properties of topological spaces and structures defined on them.
2. To introduce the student to maps between topological spaces.
3. To develop the student's ability to handle abstract ideas of Mathematics and Mathematical proofs
4. Ability to handle abstract ideas of Mathematics and Mathematical proofs

**Course Outcomes (Cos):**

1. Understanding elementary properties of topological spaces and structures defined on them.
2. Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics.
3. Demonstrate familiarity with a range of examples of these structures.
4. Prove basic results about completeness, compactness, connectedness and convergence within these structures.

**Detailed Syllabus:**

Unit I: Prerequisites (08 Hours)

1.1 Cartesian Products.
1.2 Finite Sets.
1.3 Countable and Uncountable Sets.
1.4 Infinite Sets and Axiom of Choice.

Unit II: Topological Spaces and Continuous Functions (16 Hours)

2.1 Topological Spaces.
2.2 Basis for a Topology.
2.3 Order Topology.
2.4 Product Topology on $X\times Y$.
2.5 Subspace Topology.
2.6 Closed Sets and Limit Points.
2.7 Continuous Functions.
2.8 The Product Topology.

Unit III: Connected and Compact Spaces (15 Hours)

3.1 Connected spaces.
3.2 Connected Subspaces of Real Line.
3.3 Components and Local Connectedness.
3.4 Compact spaces.
3.5 Compact Subspaces of the Real Line.
3.6 Limit point compactness.

Unit IV: Countability and Separation Axioms (06 Hours)

4.1 The Countability Axioms.
4.2 The Separation axioms and Normal Spaces.
4.3 Urysohn Lemma (State Only).
4.4 The Urysohn Metrization Theorem (State Only).

**Suggested Readings :**

1. J. R. Munkres, Topology: A First Course, (Prentice Hall, Second Edition), 2000.
2. K J¨anich. Topology. Springer, 1984.
3. M A Armstrong. Basic Topology. Springer, 1983.
4. Viro, O Ivanov, V Kharlamov, and N Netsvetaev. Elementary Topology: Problem Textbook, AMS Publication, 2008.
5. K. D. Joshi, Introduction to General Topology, John Wiley & Sons.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics (Major)

| Title of the Course: Advanced Complex Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: II | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-08 | MS-MT122T | 03 | 00 | 03 | 45 | 30 | 70 | 100 |

**Learning Objectives:**

1. Introduce the fundamental ideas of the functions of complex variables and develop a
    a. clear understanding of complex analysis.
2. To understand and learn to use the Argument principle.
3. To understand certain theorems like Cauchy Integral formula,Cauchy -Goursat theorem,Liouville theorem,Moreras theorem.
4. To understand analytic function and concerned results.

**Course Outcomes (Cos):**

1. Visualize complex numbers as points of $R^2$ ,stereographic projection of complex
2. plane on the Riemann sphere.
3. Understand the significance of analyticity of complex functions leading to the Cauchy-Riemann equations.
4. Learn the role of Cauchy -Goursat theorem and Cauchy integral formula in evaluation of contour integrals.
5. Apply Liouville's theorem in the fundamental theorem of algebra.
6. Understand Stereographic projection and residues of functions.

**Detailed Syllabus:**

Unit I : The Extended Plane and its Spherical Representation (5Hours)

1.1 Introduction to complex number.
1.2 Properties of complex number.
1.3 Extended plane and it's spherical representation.
1.4 Stereographic projection.

Unit II : Analytic Functions (15 Hours)

2.1 Elementary properties.
2.2 Analytic function definition and its Examples.
2.3 Power Series(Only Statement of Theorem).
2.4 Harmonic Function and Harmonic Conjugate.
2.5 Analytic functions as mapping.
2.6 Mobius transformation.

Unit III : Complex Integration (20Hours)

3.1 Bounded variations and theorems.
3.2 Line integral.
3.3 Definition and theorem of primitive(Only statement).
3.4 The index of a closed curve.
3.5 Liouville's Theorem.
3.6 Cauchy's Theorem and integral formula.
3.7 Morera's theorem.
3.8 Counting Zero's(only examples).
3.9 The open mapping theorem and Goursat's Theorem.

Unit IV : Singularities (5Hours)

4.1 Definition and classification of singularities.
4.2 Laurent Series(Only Statement).
4.3 Definition of Residues and it's theorem.
4.4 The Argument Principle.

**Suggested Readings** :

1. John B.Conway : Functions of One Complex Variable (Second Edition)

2. J.W.Brown and R.V.Churchill – Complex Variables and Applications (Eigth Edition)

3. L.V.Alfors,Complex Analysis ,Mc Graw Hill ,1979

4.S.Ponnusamy – Foundation of Complex Analysis,Narosa Publication(Second Edition)

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar

# (Autonomous)

# Syllabus

# M.Sc.

| Title of the Course: Ring Theory | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: II | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-9 | MS-MT123T | 02 | 00 | 02 | 30 | 15 | 35 | 50 |

**Learning Objectives:**

1. To study Rings of Continuous functions.
2. To study Maximal Ideals and its properties.
3. To study the homomorphism and factorization domain of Rings.
4. To study general theory of ring and basic concepts.

**Course Outcomes (Cos)**

1. Learn about basic terminology of Ring and Rings of continuous functions.
2. Understand Ideals, Prime ideal and maximal ideals.
3. Learn various examples of Homomorphism of rings.
4. Understand the factorization domain and Eisenstein's Criterion.
5. Learn about various type of ring.

**Detailed Syllabus:**

Unit I: Rings (08 Hours)

1.1 Basic Terminologies.
1.2 Rings of Continuous functions.
1.3 Matrix Rings, Polynomial Rings, Power Series Rings, Laurent Rings, Boolean Rings, Some Special Rings.
1.4 Direct Products.
1.5 Several Variables.
1.6 Opposite Rings.
1.7 Characteristic of a Ring.

Unit II : Ideals (08 Hours)

2.1 Definitions.
2.2 Maximal Ideals.
2.3 Generators.
2.4 Basic Properties of Ideals.
2.5 Algebra of Ideals.
2.6 Quotient Rings.
2.7 Ideals in Quotient Rings.

Unit III: Homomorphism of Rings (06 Hours)

3.1 Definitions and Basic Properties.
3.2 Fundamental theorems.
3.3 Endomorphism Rings.

Unit IV: Factorisation Domains (08 Hours)

4.1 Division in Domains.
4.2 Euclidean Domains.
4.3 Principal Ideal Domains.
4.4 Factorisation Domains.
4.5 Unique Factorisation Domains.
4.6 Eisenstein's Criterion.

**Suggested Readings :**

1. C. Musili, Rings and Modules, 2nd Revised Edition, Narosa Publishing House,

1994.

2. Joseph Gallian, Contemporary Algebra, 7th Edition, Narosa Publishing House, 2010.

3. Dummit and Foote, Abstract Algebra, Third edition (Wiley India), 2011.

4.N. S. Gopalakrishnan,University Algebra, Second edition, Reprint 2004, New Age International (P) Limited, Publishers.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics (Major)

| Title of the Course: Advanced Numerical Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: II | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-10 | MS-MT124P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

## Learning Objectives:

1. Find the solution of the first-order and second-order equations with constant coefficients.
2. Find the summation of series finite difference techniques.
3. Find the solution of ordinary differential equation of first order by Euler, Taylor and Runge-Kutta methods.
4. To improve the student's skills in numerical methods by using the numerical analysis software and computer facilities.

## Course Outcomes (Cos):

1. Obtain numerical solution of algebraic and transcendental equations.
2. Find the convergence of roots finding methods.
3. Find the solution of system of equations by iterative techniques.
4. Solve initial value problems in differential equations by using numerical methods.
5. Apply various numerical methods in real life problems.

## Detailed Syllabus:

Unit I: Root Finding Methods (10 Hours)

1.1 Convergence.
1.2 Floating Point Number Systems, Floating-Point Arithmetic.
1.3 The Method of False Position.
1.4 Fixed Point Interaction Schemes, Newton's Method; Secant Method.
1.5 Accelerating Convergence.

Unit II: System of Equations (20 Hours)

2.1 Gaussian Elimination; Pivoting Strategies.
2.2 Error Estimates and Condition Number; LU decomposition; Direct Factorization.
2.3 Iterative Techniques for Linear Systems: Basic Concepts and Methods.
2.4 Nonlinear Systems of Equations.

Unit III: Eigenvalues and Eigenvectors (15 Hours)

3.1 The Power Method.

3.2 The Inverse Power Method.
3.3 Reduction to Symmetric Tridiagonal Form.
3.4 Eigenvalues of Symmetric Tridiagonal Matrices.

Unit IV: Differentiation and Integration (15 Hours)

4.1 Numerical Differentiation, Errors in numerical differentiation.
4.2 Numerical Integration – The Basics and Newton-Cotes Quadrature; Composite Newton Cotes Quadrature.
4.3 Euler's Method.
4.4 Higher-Order One-Step Methods: Taylor Methods.
4.5 Runge-Kutta Methods.
4.6 Multistep Methods.
4.7 Convergence and Stability Analysis.

## Suggested Readings :


1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall 2007, ISBN 978-81-317-0942-9.
2. John H. Mathews, Kurtis D. Fink, Numerical Methods Using Matlab, 4th Edition, Pearson Education (Singapore) Pte. Ltd., Indian Branch, Delhi 2005.
   (SciLab commands similar to MatLab commands can be used for problems)
3. K.E. Atkinson, An Introduction to Numerical Analysis, Second Edition, John Wiley and Sons, 1989.
4. J. L. Buchaman, P. R. Turner, Numerical Methods and Analysis, McGraw Hill, 1992 cop.
5. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 1986
6. Richard L. Burden and J. Dougas Faires, Numerical Analysis, Edition 9th, Cengage Learning, 2010.

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar
# (Autonomous)
# Syllabus
# M.Sc. Mathematics

| Title of the Course: Advanced Operations Research | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | Semester: II | | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-11 | MS-MT125P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

**Learning Objectives:**

1. Develop skills in formulating and modeling complex real-world problems as mathematical optimization models.
2. Explore algorithms for solving linear programming, nonlinear programming, and integer programming problems efficiently.
3. Understand the concepts and techniques related to multi-objective optimization.
4. Gain knowledge of applications in areas such as supply chain management, logistics, transportation, production planning, scheduling, and revenue management.

**Course Outcomes (Cos)**

1. Apply the knowledge of basic optimization techniques in order to get the best possible results from a set of several possible solutions to different problems viz. linear programming problems, transportation problems, assignment problems, unconstrained and constrained problems, etc.
2. Understand the theoretical foundation and implementation of similar type optimization techniques available in the scientific literature.
3. Extend their knowledge of basic optimization techniques to do interesting research work on these types of optimization techniques.
4. Formulate an optimization problem from its physical consideration.

**Detailed Syllabus:**

Unit I: Sequencing Theory (15 Hours)

1.1 Sequencing theory.
1.2 Processing of n-jobs through two machines.
1.3 Three machines and m machines.
1.4 Graphical Method.
1.5 Transshipment Problems, Optimal Solution.
1.6 Stepping Stone Method.
1.7 Crew Assignment problem.
1.8 Travelling Salesperson's Problem.
1.9 Simulation: Introduction, Methodology of simulation, Basic concepts, Simulation procedure, Applications of simulation.

Unit II: Replacement (15 Hours)

2.1 Replacement of items that deteriorate.
2.2 Problems of choosing between two machines.
2.3 Problems in mortality and staffing.
2.4 Introduction to Inventory Systems: Analytical structure of Production and Inventory problems.
2.5 Objectives of Inventory management. Factors influencing inventories.
2.6 Inventory related costs.
2.7 Properties of Inventory systems.
2.8 Selective Inventory control techniques and its applications.
2.9 Concept of Lead time, VED and ABC analysis, Different types of demand pattern, Concept of deterioration and shortages.

Unit III: Network analysis (20 Hours)

3.1 Construction of the network diagram.
3.2 Critical path – float and slack analysis.
3.3 Total float, Free float, Independent float.
3.4 Shortest-path problem, Minimum spanning tree problem.
3.5 Maximum flow problem, Minimum cost flow problem.
3.6 Project planning and control with PERT/CPM.
3.7 Programme Evaluation Review Technique (PERT), Project Time Crashing.

Unit IV: Introduction to Game Theory (10 Hours)

4.1 Principles of decision making.
4.2 Two person Zero – sum game, Pure strategy, Saddle point.
4.3 Dominance Rule, Mixed strategy.
4.4 Reduction of m * n game and solution of 2*2, 2*s and 2*2 cases by Graphical and Algebraic methods and formulation to Linear Programming Problem (LPP).
4.5 Sub-game method, Graphical solutions, Iterative method, Solutions by linear programming.

**Suggested Readings :**


1. Bazarra, M. S; Sherali ,H.D., and Shetty, C. M., Nonlinear Programming: Theory and Algorithms, 2nd Edn., John Wiley, 1993. (Available as WSE (2004) edition).
2. Bertsekas, D.P. Nonlinear Programming, 2nd Edition., Athena Scientific, 1999.
3. Hadley, G.: Linear Programming, Narosa Publishing House, 1995.
4. Hillier, F.S. and Lieberman, G.J.: Introduction to Operations Research (6th Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995.
5. Rao, S.S.: Optimization Theory and Applications (2nd Edition), New Age Int., New Delhi, 1995.
6. Swarup, K., Gupta, P.K. and Mohan Man: Operations Research (9th Edition), S. Chand and Sons, New Delhi, 2002.
7. Taha, H.A.; Operations Research: An Introduction (10th Edition), Pearson Publication, (2019)

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics

| Title of the Course: Mathematical Statistics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | Semester: II | | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSC-12 | MS-MT126P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

**Learning Objectives:**

1. The aim of this course is to provide knowledge of probability and statistical methods and to provide theoretical background for studying advanced statistical methods.
2. Students will formulate complete, concise, and correct mathematical derivations of Central Tendency and Dispersion.
3. To understand discrete and continuous random variables and their probability mass function (p.m.f) and probability density function (p.d.f).
4. To explore the basic ideas about correlation and regression, its interpretation.

**Course Outcomes (Cos)**

1. Explore the basic ideas about measures of central tendency, dispersion, skewness and kurtosis with their applications and basic ideas about probability theory.
2. Demonstrate the understanding of random variable, expectation, variance and some discrete distributions.
3. Explain the different types of continuous distributions and their utilization.
4. Able to calculate simple linear regression models and to use the model to predict the variables outcome.

**Detailed Syllabus:**

Unit I: Central Tendency and Dispersion (15 Hours)

1.1 Measures of central tendency and Dispersion.
1.2 Moments, measures of skewness and kurtosis.
1.3 Correlation and regression.
1.4 Axiomatic approach to the theory of probability, sample space additive and multiplicative law of probability, conditional probability.

Unit II: Random Variables and Distribution function (15 Hours)

2.1 Introduction to random variables.
2.2 Discrete and continuous random variables, probability mass and density functions, distribution function.
2.3 Uniform continuous distribution, Exponential, Gamma distribution.
2.4 Bernoulli distribution, Binomial distribution, Poisson distribution, Geometric

distribution.

2.5 Fitting of Binomial and Poisson distribution.

Unit III: Mathematical Expectation (15 Hours)

3.1 Introduction.
3.2 Mathematical expectation for discrete and continuous random variables.
3.3 Covariance.
3.4 Variance for discrete and continuous random variables.
3.5 Theorems and properties of expectation and variance.

Unit IV: Correlation and Regression (15 Hours)

4.1 Introduction to bivariate distribution and correlation.
4.2 Karl Pearson Coefficient of Correlation.
4.3 Spearman’s Rank Correlation Coefficient.
4.4 Introduction to regression.
4.5 Lines of regression, regression coefficients and their properties.
4.6 Angle between Lines of regression.

**Suggested Readings:**

1. Gupta, S. C. and Kapoor, V. K. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, 2014.
2. Meyer, P. L. Introductory Probability and Statistical Applications. 2nd edition, Addison-Wesley Publishing Company, 2017.
3. Mood, A. M., Graybill, F. A. and Boes, D. C. Introduction to the Theory of Statistics, Tata McGraw Hill, 2014.
4. Spiegel, M. R., Schiller, J. J. and Srinivasan, R. A. Probability and Statistics. Tata McGraw-Hill, 2014.
5. Rohatgi, V.K., Saleh, A.K. Md. Ehsanes: An Introduction to Probability and Statistics, Second Edition Wiley-Inderscience. (2008)
6. Sheldon M. Ross, Introduction To Probability And Statistics For Engineers And Scientists, University of California, Berkeley, Fifth Edition, 2014.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

# New Arts, Commerce and Science College, Ahmednagar
# (Autonomous)
# Syllabus
# M.Sc. Mathematics

| Title of the Course: Partial Differential Equations | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | | Semester: II | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSE-03 | MS-MT127T | 02 | 00 | 02 | 30 | 15 | 35 | 50 |

**Learning Objectives:**

1. Introduce students to partial differential equations
2. Solve linear Partial Differential with different methods.
3. Find the solutions of PDEs are determined by boundary conditions.
4. Know basic analytical techniques for solving the above classical equations.

**Course Outcomes (Cos):**

1. Solve linear partial differential equations of both first and second order.
2. Classify partial differential equations and transform into canonical form.
3. Solve Boundary value problems.
4. Understand what are well-posed initial value problems or Boundary value problems for classical PDEs such as the wave equation, the Laplace equation and the heat equation.

**Detailed Syllabus:**

Unit I: Introduction to Partial Differential Equations of First Order (12 Hours)

- 1.1 Genesis of first order P.D.E.
- 1.2 Compatible systems.
- 1.3 Charpit's method.
- 1.4 Jacobi's method.
- 1.5 Quasi-linear equations.
- 1.6 Non Linear first order P.D.E.

Unit II: Fundamental Concepts (06 Hours)

- 2.1 First order partial differential equations.
- 2.2 Classification of Second Order PDE.
- 2.3 Canonical Forms, Canonical Form for Hyperbolic Equation.
- 2.4 Canonical Form for Parabolic Equation, Canonical Form for Elliptic Equation.

Unit III: Elliptic and Parabolic Differential Equations (06 Hours)

- 3.1 Occurrence of the Laplace and Poisson Equations, Derivation of Laplace Equation, Derivation of Poisson Equation.
- 3.2 Boundary Value Problems (BVPs).
- 3.3 Green's first and second identities.
- 3.4 Separation of variables method: Dirichlet problem for rectangle, Diffusion equation.

Unit IV: Hyperbolic Differential Equations (06 Hours)

4.1 Introduction.
4.2 Occurrence of the Wave Equation.
4.3 Derivation of One-dimensional Wave Equation.
4.4 Vibrating string problem- Variable separable solution.

**Suggested Readings:**

1. An Elementary Course in Partial Differential Equations, T. Amarnath, Narosa Publication, Second Edition.
2. Introduction to Partial Differential Equations, K.Sankara Rao, PHI Learning Private Limited, Third Edition.
3. Elements of Partial Differential Equations, Ian Sneddon, Dover Publication 2013.
4. An Introduction to Partial Differential Equations, Yehud Pinchor and Jaco Rubinstein, Cambridge University Press, 2018.

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# New Arts, Commerce and Science College, Ahmednagar

## (Autonomous)

## Syllabus

## M.Sc. Mathematics

| Title of the Course: Combinatorics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | Semester: II | | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| DSE-04 | MS-MT128P | 00 | 02 | 02 | 60 | 15 | 35 | 50 |

**Learning Objectives:**

1. To introduce the students to various techniques in combinatorics by guiding them through a set of carefully chosen problems.
2. Course will give students the combinatorial tools to model and analyze practical problems in various areas.
3. To learn practical problem-solving skills, which can be later applied in algorithmic theory.
4. To impart the knowledge of counting principles which is essential for the students to think critically and apply it in real-world problems.

**Course Outcomes (Cos):**

1. To apply combinatorial principles and techniques to solve counting problems.
2. To compute a generating function and apply it to solve combinatorial problems.
3. To set up and solve a linear recurrence relation.
4. To communicate mathematical arguments and ideas in appropriate mathematical language.

**Details of Syllabus:**

Unit I: General counting methods for Arrangements and Selection (16 Hours)

1.1 Two Basic Counting Principles.
1.2 Simple Arrangements and Selections.
1.3 Arrangements and Selections with Repetitions.
1.4 Distributions.
1.5 Binomial Identities.

Unit II: Generating functions (13 Hours)

2.1 Generating Function Models.
2.2 Calculating Coefficients of Generating Functions.
2.3 Partitions.
2.4 Exponential Generating Functions.

Unit III: Recurrence relations (11 Hours)

3.1 Recurrence Relation Models.
3.2 Divide-and-Conquer Relations.

3.3 Solution of Linear Recurrence Relations.

Unit IV: Inclusion-exclusion (05 Hours)

4.1 Counting with Venn Diagrams.
4.2 Inclusion-Exclusion Formula.
4.3 Restricted Positions.
4.4 Rook Polynomials.

**Suggested Readings :**

1. Alan Tucker, Applied Combinatorics (fourth edition), John Wiley & sons , New York (1995).
2. V. Krishnamurthy, Combinatorial, Theory and Applications, East West Press, New Delhi (1989).
3. K .D. Joshi: Foundations of discrete mathematics, third edition Wiley 2008.
4. Marshall Hall, Combinatorial theory, second edition,Wiley 2013.

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# New Arts, Commerce and Science College, Ahmednagar

# (Autonomous)

# Syllabus

# M.Sc. Mathematics

| Title of the Course: Programming Language: C | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year: I | | | Semester: II | | | | | |
| Course Type | Course Code | Credit Distribution | | Credits | Allotted Hours | Allotted Marks | | |
| | | Theory | Practical | | | CIE | ESE | Total |
| OJT-1 | MS-MT129P | 00 | 04 | 04 | 60 | 30 | 70 | 100 |

**Learning Objectives:**

1. Familiarize the students with problem solving through different softwares.
2. Give exposure to basic concepts of the programming languages.
3. Provide hands-on-training with the concepts.
4. Understand to implement various matrix operations with the help of Array and able to use string operation in programs.

**Course Outcomes (Cos):**

1. Classify and overview the programming languages and develop basic logic.
2. Use various operators, expressions and input/output statements.
3. Understand control flow using conditional branching and loop structures and the concept of array in problem solving.
4. Gain basic skills to write programs for simple mathematical problems.

**Detailed Syllabus:**

Unit I: Introduction (15 hours)

1.1 An overview of programming, programming languages, classification, C essentials program development, anatomy of a C function.
1.2 Variables, constants, expressions, assignment statements.
1.3 Formatting source files, continuation character, the pre-processor, scalar data types-declarations.
1.4 Different types of integers, different kinds of integer constants, floating point types, initialization, mixing types, explicit conversions-casts, data types.

Unit II: Assignments and Expressions (15 hours)

2.1 Operators and expressions - precedence and associatively, unary plus and minus operators.
2.2 Binary arithmetic operators, arithmetic assignment operators.
2.3 Increment and decrement operators, comma operator, relational operators, logical operators, bit manipulation operators, bitwise assignment operators.
2.4 Cast operator, size of operators, conditional operator, memory operators, input/output functions.

Unit III: Conditional Statements (16 hours)

3.1 Control Flow - conditional branching, the switch statement.
3.2 Looping, nested loops, break and continue statements, goto statement, infinite loops.

3.3 Arrays - declaring an array, arrays and memory, initializing arrays.
3.4 Encryption and decryption, multidimensional arrays, strings.

Unit IV: Functions and Pointers (14 hours)

4.1 Functions - passing arguments, declarations and calls.
4.2 Recursion, the main ( ) function, passing arrays as function arguments.
4.3 Pointers - pointer arithmetic, accessing array elements through pointers.
4.4 Passing pointers as function arguments, arrays of pointers.

**Suggested Readings:**

1. Balagurusamy, E. Programming in ANSI C. 3rd edition. TATA McGraw Hill, 2016.

2. Brain W. K. and Ritchie D. M. C Programme Language. 2 nd edition, Pearson, 2015.

3. Darnell, P. A. and Margolis, P. E. C: A Software Engineering Approach. Narosa Publishing, House (Springer International Student Edition), 2012.

4. Yashavant, P. K. Let Us C. BPB Publication, 2008.

5. Byrons, G. Programming With C. 2nd edition, Schaum's Series, 1996.