


**Deccan Education Society's**

# Fergusson College (Autonomous), Pune

Learning Outcomes-Based Curriculum

for 3/4 years B. Sc. / B. Sc. (Honours) Programme

as per guidelines of

**NEP-2.0**

for

## F. Y. B. Sc. (Mathematics)

With effect from Academic Year

**2024-2025**

**B.Sc. Major Mathematics**

**Program Outcomes (POs)**

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|---|---|
| **PO1** | **Disciplinary Knowledge**<br>Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work. |
| **PO2** | **Critical Thinking and Problem solving**<br>Exhibitthe skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions. |
| **PO3** | **Social competence**<br>Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise way and help reach conclusions in group settings. |
| **PO4** | **Research-related skills and Scientific temper**<br>Infer scientific literature, build a sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism. |
| **PO5** | **Trans-disciplinary knowledge**<br>Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem. |
| **PO6** | **Personal and professional competence**<br>Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics. |
| **PO7** | **Effective Citizenship and Ethics**<br>Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility. |
| **PO8** | **Environment and Sustainability**<br>Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development. |
| **PO9** | **Self-directed and Life-long learning**<br>Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes. |

**Program Specific Outcomes (PSOs) of Department of Mathematics**
**(As per the revised curriculum under NEP, departments should revisit and change PSOs as per requirement)**

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|---|---|
| **PSO1** | Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of mathematics. This also leads to study of related areas like computer science and statistics. Thus, this programme helps learners in building a solid foundation for higher studies in mathematics. |
| **PSO2** | The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilised in modelling and solving real life problems. |
| **PSO3** | Students undergoing this programme learn to logically question assertions, to recognise patterns and to distinguish between essential and irrelevant aspects of problems. They also share ideas and insights while seeking and benefitting from knowledge and insight of others. This helps them to learn behave responsibly in a rapidly changing interdependent society. |
| **PSO4** | Students completing this programme will be able to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians. |
| **PSO5** | Completion of this programme will also enable the learners to join teaching profession in primary and secondary schools. |
| **PSO6** | This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises. |

# Fergusson College (Autonomous), Pune

# NEP 2.0 Subject Credit Distribution Structure 2024-25

# Department of Mathematics (Science)

| FYBA Sem-I | Theory/Practical | Paper Code | Paper Title | Credits | Exam Type |
|---|---|---|---|---|---|
| Discipline Specific Core DSC | Theory | MTS-1001 | Algebra | 2 | CE+ESE |
| Discipline Specific Core, DSC | Practical | MTS-1011 | Practical 1 | 2 | CE+ESE |
| Open Elective-1 (For Other faculty) | Theory | MTS-1021 | Introduction to Quantitative and Logical Thinking-I | 2 | Only CE |

| FYBA Sem-II | Theory/Practical | Paper Code | Paper Title | Credits | Exam Type |
|---|---|---|---|---|---|
| Discipline Specific Core DSC-3 | Theory | MTS-1002 | Calculus | 2 | CE+ESE |
| Discipline Specific Core DSC-4 | Practical | MTS-1012 | Practical 2 | 2 | CE+ESE |
| Open Electice-2 (For Other faculty) | Theory | MTS-1022 | Introduction to Quantitative and Logical Thinking-II | 2 | Only CE |
| Skill Enhancement Course, SEC-1 | Theory/Practical | MTS-1032 | Foundation of Computational Mathematics | 2 | Only CE |

**Class: F. Y. B. Sc. Sem. I**

**Paper Code: MTS-1001 Paper Title: Algebra Number of Credits:02**

| Sr.No. | Course Outcome | Blooms Taxonomy Level | Weightage in % |
|---|---|---|---|
| 1 | CO-1: Remember the properties of sets, functions, operations on matrices | Remember | 10 |
| 2 | CO-2: Understand the nature of function, properties of real numbers | Understand | 20 |
| 3 | CO-3: Apply techniques to find determinant, eigenvalues, eigenvectors. Apply properties of real numbers to find supremum and infimum | Apply | 25 |
| 4 | CO-4: Analyse the matrices and discuss the properties | Analyse | 15 |
| 5 | CO-5: Evaluate the equivalence classes, determinants, eigenvalues and eigenvectors. | Evaluate | 20 |
| 6 | CO-6: Generate the functions with given data, create matrix required conditions, inequalities | Create | 10 |

| Unit No. | Title of Unit and Contents | No. of hours |
|---|---|---|
| I | **Sets, Relations and Functions**<br>1.1 Sets, Operations on Sets, Power Set, Cartesian product of Sets, Graphical representation of sets<br>1.2 Relations, types<br>Relations,reflexive, symmetric,<br>transitive and equivalence relation<br>1.4 Partition of a set and equivalence classes.<br>1.5 Matrix representation and composition of relations.<br>1.6 Types of functions (One – One, Onto, Bijective). | **10** |
| | **Sets, Relations and Functions**<br>1.1 Sets, Operations on Sets, Power Set, Cartesian product of Sets, Graphical representation of sets<br>1.2 Relations<br>1.3 Reflexive, symmetric, transitive and equivalence relation<br>1.4 Partition of a set and equivalence classes. | |

| | | |
|---|---|---|
| | 1.6 Types of functions (One – One, Onto, Bijective). | |
| **II** | **Matrices**<br>2.1 Systems of linear equations<br>2.2 Row reduction and echelon forms<br>2.3 The rank of a matrix and applications;<br>2.4 Matrix operations,<br>2.5 Determinants,<br>2.6 The inverse of a matrix,<br>2.7 Characterizations of invertible matrices;<br>2.8 Eigen values and eigenvectors,<br>2.9 The characteristic equation and the Cayley-Hamilton theorem. | **10** |
| **III** | **Real Numbers**<br>3.1 Introduction of real numbers<br>3.2 Well ordering property, inductive property<br>3.3 Absolute value and its properties<br>3.4 Completeness property<br>3.5 Density of rational numbers | **10** |

| | |
|---|---|
| **Reference Books** | 1. Robert Bartle, Donald Sherbert, Introduction to Real Analysis (Fourth Edition), John Wiley and Sons Inc.<br>2. Ajit Kumar, S. Kumaresan and B. K. Sarma, A Foundation Course in Mathematics, Narosa<br>3. David M. Burton, Elementary number theory, Seventh Edition, Tata McGraw Hill, 2012.<br>4. Howard Anton, Chris Rorres, Elementary Linear Algebra: Applications Version, Wiley (11th Edition).<br>5. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7th edition). Pearson Education Pvt. Ltd. India.<br>6. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and its Applications* (5th edition). Pearson Education Pvt. Ltd. India. |

**Class: F. Y. B. Sc. Sem. I**

**Paper Code: MTS-1011** **Paper Title: Practical 1** **Number of Credits:02**

| Sr.No. | Course Outcome | Blooms Taxonomy Level | Weightage in % |
|---|---|---|---|
| 1 | CO-1: Remember the properties of functions, equivalence relation | Remember | 10 |
| 2 | CO-2: Understand the statements and use them in solving the problems | Understand | 20 |
| 3 | CO-3: Apply the definitions and statements to solve the problems | Apply | 20 |
| 4 | CO-4: Analyse the problems and make conclusions | Analyse | 20 |
| 5 | CO-5: Evaluate the equivalence class, eigenvalue, eigenvectors, determinants, supremum | Evaluate | 20 |
| 6 | CO-6: Create the examples for the given data | Create | 10 |

| Unit No. | Title of Unit and Contents |
|---|---|
| 1 | Applications of properties of sets, Construction of functions, sketching graphs of functions |
| 2 | Applications of equivalence relations |
| 3 | Congruence relation, Modular arithmetic |
| 4 | Construction and properties of bijective functions |
| 5 | Applications of partition of set and computation of equivalence classes |
| 6 | Application of relation to graphs |
| 7 | Applications of system of linear equations |
| 8 | Determinants and its applications |
| 9 | Applications of eigenvalues and eigenvectors |
| 10 | Properties of real numbers, absolute value and applications |
| 11 | LUB axioms and its applications |
| 12 | Applications of density of rational numbers |

**Class: F. Y. B. Sc. Sem. I**

**Paper Code: MTS-1021**

**Paper Title: Introduction to Quantitative and Logical Thinking-I** **Number of Credits:02**

| Sr.No. | Course Outcome | Blooms Taxonomy Level | Weightage in % |
|---|---|---|---|
| 1 | CO-1: | Understand basic concepts of Integers, Rational and Irrational numbers. | 20 |
| 2 | CO-2: | Familiarize basic concepts of Permutation and Combinations. | 15 |
| 3 | CO-3: | Interpret the concepts of Logical Reasoning Skills | 15 |
| 4 | CO-4: | Solve the problems easily by using short-cut method with time management which will be helpful to them to clear the competitive exams for better job opportunity. | 20 |
| 5 | CO-5: | Analyse the problems logically and approach the problems in a different manner like Probability | 20 |
| 6 | CO-6: | Construct the problems based on Ages | 10 |

| Unit No. | Title of Unit and Contents | No. of hours |
|---|---|---|
| I | 1.1 Whole numbers<br>1.2 Integers<br>1.3 Rational and irrational numbers<br>1.4 Fractions<br>1.5 Square roots and Cube roots<br>1.6 Surds and Indices<br>1.7 Problems on Numbers<br>1.8 Divisibility. | **8** |
| **II** | 2.1 Highest Common Factor and Least Common Multiple<br>2.2 Permutation and Combination,<br>2.3 Probability<br>2.4 Ratio and Proportion<br>2.5 Percentage<br>2.6 Average<br>2.7 Problems Based on Ages<br>2.8 Profit and Loss<br>2.9 Squares and Square Roots<br>2.10 Cubes and Cube Roots. | **16** |
| **III** | 3.1 Series<br>3.2 Progression and Sequence | **6** |

**Learning Resources:**

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|---|---|
| **Reference Books** | 1. R. V. Praveen Quantitative Aptitude and Reasoning, PHI Learning Pvt Ltd<br>2. Dinesh Khattar, Quantitative Aptitude for Competitive Examinations, Pearson<br>3. R.S. Aggarwal Quantitative Aptitude |

**Class: F. Y. B. Sc. Sem. II**

**Paper Code: MTS-1002 Paper Title: Calculus Number of Credits: 02**

| Sr.No. | Course Outcome | Blooms Taxonomy Level | Weightage in % |
|---|---|---|---|
| 1 | CO-1: Remember the definitions and statements | Remember | 10 |
| 2 | CO-2: Understand the theorem to and write the proof | Understand | 25 |
| 3 | CO-3: Apply the statements to solve the problems | Apply | 20 |
| 4 | CO-4: Analyse the statements to define the necessary and sufficient conditions | Analyse | 15 |
| 5 | CO-5: Solve the problems of limit, evaluate the extreme values | Evaluate | 20 |
| 6 | CO-6: Generate the new statements from the given data. | Create | 10 |

| Unit No. | Title of Unit and Contents | No. of hours |
|---|---|---|
| I | **Sequences of Real Numbers**<br>1.1 Sequences of real numbers and convergence of sequences<br>1.2 Evaluation of limit of sequences<br>1.3 Monotone and bounded sequences<br>1.4 Subsequences<br>1.5 Monotone sequences and subsequence and applications<br>1.6 Definition of Cauchy sequence | **8** |
| II | **Limits of functions:**<br>2.1 Cluster point<br>2.2 Definition of limit<br>2.3 Limits of some standard functions<br>2.4 Sequential criteria for limits,<br>2.5 Uniqueness of limit<br>2.6 Divergence criteria<br>2.7 Algebra of limits<br>2.8 Squeeze theorem for limit | **8** |
| III | **Continuous functions:**<br>3.1 Definition<br>3.2 Sequential criteria and examples<br>3.3 Composition of continuous functions<br>3.4 Continuous functions on intervals<br>3.5 Boundedness theorem<br>3.6 Maximum-Minimum theorem (statement only)<br>3.7 Location of roots theorem (statement only)<br>3.8 Intermediate value theorem<br>3.9 Fixed point theorem<br>3.10 Preservation of intervals theorem | **8** |
| IV | **Derivative:**<br>4.1 Definition<br>4.2 Differentiability imply continuity<br>4.3 Non differentiable functions<br>4.4 Algebra of differentiable functions<br>4.5 Derivative of composition of functions and chain rule<br>4.6 Derivative of inverse function | **6** |

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|---|---|
| **Reference Books** | 1. Robert Bartle, Donald Sherbert, Introduction to Real Analysis (Fourth Edition), John Wiley and Sons Inc.<br>2. Michael Spivak, Calculus, Cambridge University Press.<br>3. Thomas' Calculus (14th edition), Pearson Education.<br>4. Howard Anton, I. Bivens& Stephan Davis (2016). Calculus (10th edition). Wiley India.<br>5. Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag. |
| **E-resources** | 1. E-Books: https://sites.google.com/site/vvacharyanew/<br>2. https://studio.youtube.com/channel/UChCsGynvfLk4g0DpgvXXvJA/videos |

**Class: F. Y. B. Sc. Sem. II**

**Paper Code: MTS-1012** **Paper Title: Practical 2** **Number of Credits:02**

| Sr.No. | Course Outcome | Blooms Taxonomy Level | Weightage in % |
|---|---|---|---|
| 1 | CO-1: Remember the statements, theorems | Remember | 10 |
| 2 | CO-2: Understand the geometry of functions through statements, examples | Understand | 20 |
| 3 | CO-3: Apply the statements in solving problems | Apply | 20 |
| 4 | CO-4: Analyse the statements, theorems and solve the problems | Analyse | 20 |
| 5 | CO-5: Evaluate limit, critical points, extreme values, etc. | Evaluate | 20 |
| 6 | CO-6: Create counter examples, construct new examples for the desired data. | Create | 10 |

| Unit No. | Title of Unit and Contents |
|---|---|
| 1 | Evaluation of limit of sequences |
| 2 | Monotone sequences and subsequence and applications, Cauchy sequence |
| 3 | Continuous functions and their properties |
| 4 | Applications of Boundedness theorem |
| 5 | Maxima Minima theorem, Intermediate value theorem |
| 6 | Applications of fixed-point theorem, preservation of interval theorem |
| 7 | Piecewise continuous functions and applications |
| 8 | Computation of derivative of function |
| 9 | Mean value theorems and applications |
| 10 | Increasing and decreasing functions, extreme value, concavity |

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| 11 | Successive differentiation and applications |
| 12 | Taylor's theorem and applications |

**Class: F. Y. B. Sc. Sem. II**

**Paper Code: MTS-1022**

**Paper Title: Introduction to Quantitative and Logical Thinking-II (OE-2)**

**Number of Credits:02**

| Sr.No. | Course Outcome | Blooms Taxonomy Level | Weightage in % |
|---|---|---|---|
| 1 | CO-1: | Understand basic concepts Polynomials, Quadratic equations | 15 |
| 2 | CO-2: | Familiarize basic concepts of simple and compound interest. | 20 |
| 3 | CO-3: | Interpret the Venn diagram | 15 |
| 4 | CO-4: | Solve the problems on Clock Train and Calendar | 20 |
| 5 | CO-5: | Analize the problems on Heights and Distances | 20 |
| 6 | CO-6: | Construct the Venn diagram. | 10 |

| Unit No. | Title of Unit and Contents | No. of hours |
|---|---|---|
| **I** | 1.1 Algebra of Polynomials<br>1.2 Quadratic Equations<br>1.3 Partnership<br>1.4 Simple Interest.<br>1.5 Compound Interest | **10** |
| **II** | 2.1 Time and Work<br>2.2 Work and Wages<br>2.3 Pipes and Cistern<br>2.4 Allegation<br>2.5 Problems on Trains | **10** |
| **III** | 3.1 Problems on Clock<br>3.2 Problems on Calendar<br>3.3 Time and Distances<br>3.4 Heights and Distances<br>3.5 Set and Venn Diagram | **10** |

**Learning Resources:**

| | |
|---|---|
| **Reference Books** | 1. R. V. Praveen,Quantitative Aptitude and Reasoning<br>2. Dinesh Khattar, Quantitative Aptitude for Competitive Examinations-Pearson Education (2020)<br>3. R.S. Aggarwal Quantitative Aptitude PHI Learning Pvt. Ltd |

**Class: F. Y. B. Sc. Sem. II**

**Paper Code: MTS-1032**

**Paper Title: Foundation of Computational Mathematics (SEC-1)**

**Number of Credits:02**

| Sr.No. | Course Outcome | Blooms Taxonomy Level | Weightage in % |
|---|---|---|---|
| 1 | CO-1: Remember the matrix operations and use it for calculations | Remember | 20 |
| 2 | CO-2: Understand the statement and implement in programming | Understand | 20 |
| 3 | CO-3: Apply statements to solve the problems using software | Apply | 20 |
| 4 | CO-4: Analyse the statement using output of the program | Analyse | 10 |
| 5 | CO-5: Evaluate the determinant, eigenvalues etc. Using the software | Evaluate | 20 |
| 6 | CO-6: Create the statements, problems from the observations. | Create | 10 |

| Unit No. | Title of Unit and Contents | No. of hours |
|---|---|---|
| I | **Statements and Logic**<br>1.1 Introduction of complex numbers, argument, Modulus, De'Moivre's theorem, nth root of complex number<br>1.2 Statements with quantifiers, Compound Statements, Implications | 10 |
| II | **Use of Computational Software for mathematics**<br>2.1 Introduction to computational softwares: Maxima/Scilab/SAGE/ Mathematica/Matlab<br>2.2 Sketching graph<br>2.3 Modular arithmetic through software<br>2.4 Matrix operations, addition, multiplication, inverse, determinant<br>2.5 System of linear equations, rank of matrix, characteristic polynomial, eigenvalues and eigenvectors<br>2.6 Complex Numbers: Real and Imaginary parts, modulus, addition, multiplication, argument, power, nth root, solving equations, logarithm | 10 |

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|---|---|---|
| **III** | **Calculus**<br>3.1 Computation of terms of sequences<br>3.2 Guess limit of a function from its graph<br>3.3 Guess limit of a function by evaluation of a function at different points<br>3.4 Guess limit of a function by evaluation of a function at terms of sequence<br>3.5 Guess delta for epsilon in the definition of limit<br>3.6 Continuity of function from graph, sequences<br>3.7 Bounds for function, maximum values, minimum values, monotone function, location of roots<br>3.8 Differentiability from the graph, calculation of derivative, monotonicity of a function using derivative, concavity, extreme values. | **10** |

**Learning Resources:**

| | |
|---|---|
| **Reference Books** | 1. Ajit Kumar, S. Kumaresan and B. K. Sarma, A Foundation Course in Mathematics, Narosa<br>2. Robert Bartle and Donald Sherbert, Introduction to real Analysis (Fourth Edition), John Wiley and Sons Inc.<br>3. Kenneth Rosen, Discrete Mathematics and its Applications (Seventh Edition), Mc Graw Hill.<br>4. Vaisakh Venu, Maxima: The Computer Algebra System,<br>5. Paulo Ney de Souza, Richard J. Fateman, Joel Moses, Cliff Yapp, The Maxima book<br>6. Sandeep Nagar, Introduction to Scilab: For Engineers and Scientists, Apress<br>7. Akhilesh Kumar, Programming Using Scilab-Theory and Practicals<br>8. Michael Trott, The Mathematica GuideBook for Programming, Springer |
| **E-resources** | 1. E-Books: https://sites.google.com/site/vvacharyanew/<br>2. https://reference.wolfram.com/language/<br>3. https://studio.youtube.com/channel/UChCsGynvfLk4g0DpgvXXvJA/videos |