Deccan Education Society's

Fergusson College (Autonomous), Pune

Learning Outcomes-Based Curriculum

for 3/4 years B**.** A. / B. A. (Honours) Programme

as per guidelines of

NEP-2020

for

F. Y. B. A. (Mathematics)

With effect from Academic Year

2024-2025

B.A. Major Mathematics

Program Outcomes (POs)

PO1	**Disciplinary Knowledge** 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** Exhibittheskill 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** 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 clearand concise way and help reach conclusions in group settings.
PO4	**Research-related skills and Scientific temper** Infer scientific literature, build a sense of enquiry and able to formulate, test, analyze, 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 emphasizingonacademics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge** 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** 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** 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** Understand the impact of thescientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning** 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)

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 (Arts)

FYBA Sem-I	Theory/Practical	Paper Code	Paper Title	Credits	Exam Type
Discipline Specific Core DSC	Theory	MTS-1111	Algebra	4	CE+ESE
Open Electice-1 (For Other faculty)	Theory	MTS-1121	Ordinary Differential Equations	2	Only CE

FYBA Sem-II	Theory/Practical	Paper Code	Paper Title	Credits	Exam Type
Discipline Specific Core DSC-3	Theory	MTS-1112	Calculus	4	CE+ESE
Open Electice-2 (For Other faculty)	Theory	MTS-1122	Vector Calculus	2	Only CE
Skill Enhancement Course, SEC-1	Theory/Practical	MTS-1132	Foundation of Computational Mathematics	2	Only CE

Class: F. Y. B. A. Sem. I

Paper Code: MTS-1111 Paper Title: Algebra Number of Credits:04

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** 1.1 Sets, Operations on Sets, Power Set, Cartesian product of Sets, Graphical representation of sets 1.2 Relations, types of Relations. 1.3 Equivalence relations. 1.4 Partition of a set and equivalence classes. 1.5 Matrix representation and composition of Relations. 1.6 Types of functions (One – One, Onto, Bijective).	**10**
II	**Row Echelon Form of Matrices and Applications** 2.1 Systems of linear equations 2.2 Row reduction and echelon forms 2.3 The rank of a matrix and applications; 2.4 Matrix operations, 2.5 Determinants,	**10**

	2.6 The inverse of a matrix, 2.7 Characterizations of invertible matrices; 2.8 Eigen values and eigenvectors, 2.9 The characteristic equation and the Cayley-Hamilton theorem.	
III	**Real Numbers** 3.1 Introduction of real numbers 3.2 Well ordering property, inductive property 3.3 Absolute value and its properties 3.4 Completeness property 3.5 Density of rational numbers	**10**
IV	**Sets** 4.1 Properties of sets 4.2 Construction of functions 4.3 Properties of bijective functions 4.4 Sketching graphs of functions 4.5 Partition of set and equivalence relations 4.6 Congruence relation and their properties 4.7 Integers modulo n	**10**
V	**System of Linear Equations:** 5.1 Introduction 5.2 Applications of system of linear equations 5.3 Determinants and their properties 5.4 Applications of eigenvalues and eigenvectors.	**10**
VI	**LUB axioms and It's application:** 6.1 Introduction 6.2 Properties of real numbers 6.3 Absolute value and applications 6.4 LUB axioms and its applications 6.5 Applications of density of rational numbers	**10**

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

Unit No.	Title of Unit and Contents	No. of hours

Class: F. Y. B. A. Sem. I

Paper Code: MTS-1121

Paper Title: Ordinary Differential Equations (OE-1) **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: Understanding appropriate methods to solve differential equations.	Understand	20
3	CO-3: Apply the methods of solving differential equations to real world problems.	Apply	20
4	CO-4: Categorize differential equations and explain methods of solving them.	Analyse	20
5	CO-5: Evaluate detailed solutions of differential equations	Evaluate	20
6	CO-6: Create counter examples and support the theory with applicable examples to understand the differential equations.	Create	10

I	**Differential Equations of first order and first degree:** 1.1 Differential Equations of first order and first degree: 1.2 Formation of differential equations 1.3 Solution of differential equation, Existence and uniqueness, Picard's Theorem (statement only), Sketching the solutions 1.4 Variables separable form and Homogeneous Differential Equations 1.5 Exact Differential Equations. Examples of Non Homogeneous equations. 1.6 Condition for exactness. (Necessary and sufficient condition) 1.7 Integrating factor, Rules of finding integrating factors. 1.8 Linear Differential Equations, Bernoulli's equation. 1.9 Differential equation of first order but not of degree one.	**16**
II	Linear Differential Equations with constant coefficients: 2.1 Existence and uniqueness Theorem (statement), General solution, Particular solution 2.2 General Solution of homogeneous equation: Linear dependence-independence of solutions, Wronskian. 2.3 Use of known solution to find another. 2.4 Solution of Homogeneous Equation with constant Coefficients 2.5 Solution of Non-homogeneous equations: (a) Method of undetermined coefficients (b) Method of variation of parameter (c) Method of reduction of order	**14**

Learning resources:

1. George F. Simmons, Differential Equations with Applications and Historical Notes.
2. V. V. Acharya and M. R. Modak, Differential equations, pdf book.

References:

1. Rainville and Bedient, Elementary Differential Equations, Macmillan Publication.
2. Daniel Murray, Introductory Course in Differential Equations, Orient Longman
3. G.F. Simmons and S. Krantz, Differential Equations with Applications and Historical notes, Tata Mc-Graw Hill.

Class:F. Y. B. A. Sem. II

Paper Code: MTS-1112 **Paper Title: Calculus** **Number of Credits:04**

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

Unit No.	Title of Unit and Contents	No. of hours
I	**Sequences of Real Numbers** 1.1 Sequences of real numbers and convergence of sequences 1.2 Evaluation of limit of sequences 1.3 Monotone and bounded sequences 1.4 Subsequence's 1.5 Monotone sequences and subsequence and applications	**12**
II	**Limits of functions:** 2.1 Cluster point 2.2 Definition of limit 2.3 Limits of some standard functions 2.4 Sequential criteria for limits, 2.5 Uniqueness of limit 2.6 Divergence criteria 2.7 Algebra of limits 2.8 Squeeze theorem for limit	**12**

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

III	**Continuous functions:** 3.1 Definition 3.2 Sequential criteria and examples 3.3 Composition of continuous functions 3.4 Continuous functions on intervals 3.5 Boundedness theorem 3.6 Maximum-Minimum theorem (statement only) 3.7 Location of roots theorem (statement only) 3.8 Intermediate value theorem 3.9 Fixed point theorem 3.10 Preservation of intervals theorem 3.11 Applications of Boundedness theorem, Maxima Minima theorem 3.12 Applications of Intermediate value theorem 3.13 Applications of fixed-point theorem, preservation of interval theorem 3.14 Piecewise continuous functions and applications	**20**
IV	**Derivative:** 4.1 Definition 4.2 Differentiability imply continuity 4.3 Non differentiable functions 4.4 Algebra of differentiable functions 4.5 Computation of derivative of function 4.6 Mean value theorems and applications 4.7 Increasing and decreasing functions, extreme value, concavity 4.8 Successive differentiation and applications 4.9 Taylor's theorem and applications	**16**

Learning Resources:

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

Class: F. Y. B. A. Sem. II

Paper Code: MTS-1122

Paper Title: Vector Calculus (OE-2) **Number of Credits:02**

Sr.No.	Course Outcome	Blooms Taxonomy Level	Weightage in %
1	CO-1: Retrieve basic concepts of real analysis and calculus of several variables.	Remember	10
2	CO-2: Understanding divergence and Curl, solenoidal and irrotational vector fields.	Understand	20
3	CO-3: Apply Green's theorem, Stokes theorem and Divergence theorem and solve the problems	Apply	20
4	CO-4: Analysis the concept of curl, gradient and divergence, total differentials.	Analyse	20
5	CO-5: Evaluate limit and continuity of vector valued functions, line integral, surface integral	Evaluate	20
6	CO-6: Create counter examples and support the theory with applicable examples to understand the vector calculus.	Create	10

Unit No.	Title of Unit and Contents	No. of hours
I	**Vector functions of one variable:** 1.1 Limit and continuity. 1.2 Derivatives. 1.3 Derivability in relation to algebraic operations 1.4 Limits, continuity and partial derivatives of vector function of two and three variables. 1.5 Total differentials	**10**
II	**Differential operators:** 2.1 The operator del, scalar and vector fields. 2.2 Gradient of a scalar point function, properties and its geometrical interpretation. 2.3 Directional derivatives of a scalar point function. 2.4 Divergence and curl of a vector point function and its properties.	**10**
III	**Vector Integration:** 3.1 Line Integral. 3.2 Surface Integral. 3.3 Volume Integral. 3.4 Green's theorem with proof. 3.5 Gauss's Divergence Theorem (statement only). 3.6 Stokes's Theorem (Statement only),	**10**

Learning Resources:

Textbook: V. V. Acharya and M. R. Modak, Vector Calculus, Pdf book.

Reference Books	1. T.M. Apostol, Calculus Vol. II (IInd Edition), John Willey, New York, (1967) 2. Shanti Narayan and P.K. Mittal, A Course of Mathematical Analysis, S. Chand and Co. 12th Edition, 1979. 3. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). Basic Multivariable Calculus, Springer India Pvt. Limited 4. John M. H. Olmsted, Advanced Calculus, Eurasia Publishing House, New Delhi,1970.

Class: F. Y. B. A. Sem. II

Paper Code: MTS-1132

Paper Title: Foundation of 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** 1.1 Introduction of complex numbers, argument, Modulus, De'Moivre's theorem, nth root of complex number 1.2 Statements with quantifiers, Compound Statements, Implications 1.3 Principle of Mathematical Induction 1.4 Integration	**10**
II	**Use of Computational Software for mathematics** 2.1 Introduction to computational softwares: Maxima/Scilab/SAGE/ Mathematica 2.2 Sketching graph 2.3 Modular arithmetic through software 2.4 Matrix operations, addition, multiplication, inverse, determinant 2.5 System of linear equations, rank of matrix, characteristic polynomial,eigenvalues and eigenvectors 2.6 Complex Numbers: Real and Imaginary parts, modulus, addition,multiplication, argument, power, nth root, solving equations, logarithm	**10**

III	**Calculus using software** 3.1 Computation of terms of sequences 3.2 Guess limit of a function from its graph 3.3 Guess limit of a function by evaluation of a function at different points 3.4 Guess limit of a function by evaluation of a function at terms of sequence 3.5 Guess delta for epsilon in the definition of limit 3.6 Continuity of function from graph, sequences 3.7 Bounds for function, maximum values, minimum values, monotone function, location of roots 3.8 Differentiability from the graph, calculation of derivative, monotonicity of a function using derivative, concavity, extreme values. 3.9 Integration using software	**10**

Learning Resources:

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