Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for M.Sc.I Mathematics

Semester	Paper Code	Title of Paper	No. of Credits
I	MAT4101	Real Analysis	4
	MAT4102	Advanced Calculus	4
	MAT4103	Group theory	4
	MAT4104	Numerical Analysis	4
	MAT4105	Ordinary Differential Equations	4
	MAT4106	Practical: Programming in C	4
II	MAT4201	Complex Analysis	4
	MAT4202	Topology	4
	MAT4203	Rings and Modules	4
	MAT4204	Linear Algebra	4
	MAT4205	Partial Differential Equations	4
	MAT4206	Practical: Programming in C++	4

SYLLABUS (CBCS) FOR M.Sc.I MATHEMATICS
(w.e.f. June, 2019)
Academic Year 2019-2020

Class : M.Sc I (Semester- I)

Paper Code: MAT4101

Paper : I Title of Paper : Real Analysis
Credit : 4 No. of lectures: 60

A) Learning Objectives:

To expose the students to basic and advance concepts in real analysis such as metric spaces, measure theory, Fourier analysis

B) Learning Outcome:

To understand Real Analysis and apply it to theoretical and practical problems

TOPICS/CONTENTS:

1. Metric Spaces, Normed Spaces, Inner Product Spaces:
   Definitions and Examples, Sequence Spaces, Function Spaces, Dimensions.
2. Topology of Metric Spaces:
   Open, Closed and Compact sets, The Heine-Boral and Ascoli-Arzela' Theorems, Separability, Banach and Hilbert Spaces.
3. Measure and Integration:
   Lebesgue Measure on Euclidean Space, Measurable and LebesgueIntegrable Functions, The Convergence Theorems, Comparison of Lebesgue Integral with Riemann integral, General Measure and LebesgueL^p-Spaces.
4. Fourier Analysis in Hilbert space:
   Orthonormal Sequence, Bessel's Inequality, Parseval's Theorem, Riesz-Fischer Theorem, Classical Fourier Analysis.
5. Weierstrass Approximation Theorem, Generalized Stone-Weierstrass Theorem, Baire Category Theorem and it's Applications, Contraction Mapping.

Text Book: *Beginning Functional Analysis*, Karen Saxe, Springer International Edition.

(Chapters: 1 to 4, 6.1, 6.2, 6.5)

Reference Books:

1. *Principles of Mathematical Analysis*, W. Rudin, Mc'Graw Hill.
2. *Topology of Metric Spaces*, S. Kumaresan, Narosa Publishing.
3. *Introduction to Topology and Modern Analysis*, G. F. Simmons, Mc'Graw Hill.

Class : M.Sc I (Semester- I)

Paper Code: MAT4102

Paper : II Title of Paper : Advanced Calculus

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To understand theory in Vector calculus
- To use important theorems such as Greens, Divergence, Stokes for problem solving

B) Learning Outcome:

To apply these concepts to solve practical problems arising in Physics and other related areas

TOPICS/CONTENTS:

1. Derivative of a scalar field with respect to a vector, Directional derivative, Gradient of a scalar field, Derivative of a vector field, Matrix form of the chain rule, Inverse function theorem and Implicit functiontheorem.

2. Path and line integrals, The concept of work as a line integral, Independence of path, The first and the second fundamental theorems of calculus for line integral, Necessary condition for a vector field to be agradient.

3. Double integrals, Applications to area and volume, Green's Theorem in the plane, Change of variables in a double integral, Transformation formula, Change of variables in an n-fold integral.

4. The fundamental vector product, Area of a parametric surface, Surface integrals,The theorem of Stokes, The curl and divergence of a vector field, Gauss divergence theorem, Applications of the divergencetheorem.

5. Applications of differential Calculus: Partial differential equations ,A first order partial differential equation with constant coefficients, The one Dimensional wave equation.

Text Book:

T. M. Apostol: Calculus, Vol. II (2nd edition) (John Wiley and Sons, Inc.)
Chapter 1: Sections 81 to8.22
Chapter 2: Sections 10.1 to 10.11 and 10.14 to 10.16
Chapter 3: Sections 11.1 to 11.5 and 11.19 to 11.22 and 11.26 to11.34
Chapter 4: Sections 12.1 to 12.15, 12.18 to 12.21
Chapter 5: Sections 9.1 to 9.5
(For Inverse function theorem and Implicit function theorem refer the book "Mathematical Analysis" byT. M.Apostol.)

Reference Books :

1. T. M. Apostol: Mathematical Analysis (Narosapublishinghouse)
2. W. Rudin: Principles of Mathematical Analysis (Mc-GrawHill)
3. A. Devinatz: Advanced Calculus, (Holt, Rinehart and Winston),1968

Class : M.Sc I (Semester- I)

Paper Code: MAT4103

Paper : III Title of Paper : Group Theory

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To understand abstract structures in Mathematics
- Understanding of theoretical part of Groups and how to use them to solve problems

B) Learning Outcome:

Use of Group Theory in solving problems of different of Mathematics such as Algebraic Topology, how Group Theory explains symmetry and hence have application in Physics, Chemistry and other subjects

TOPICS/CONTENTS:

1. Revision of definition and examples of groups, subgroups.
2. Cyclic Groups, Classification of subgroups of cyclic groups.
3. Permutation Groups
4. Isomorphism, Cayley's theorem, properties of isomorphisms, automorphism
5. Cosets and Lagrange's theorem. Orbit-stabilizer theorem, the rotation group of a cube and a soccer ball.
6. External Direct Products
7. Normal subgroups and factor groups, Internal direct products
8. Group Homomorphism
9. Fundamental theorem of finite abelian groups
10. Sylow theorems
11. Applications of Groups: Symmetries of square ,The dihedral groups. A check-digit scheme based on D_5 ,The rotation group of a cube and a soccer ball ,Data Security ,Public key cryptography.

Text Books: Joseph Gallian – Contemporary Abstract Algebra (Narosa Publishing House).Chapter 2 to 11, 24, 25.

Reference Books:

1. I.S. Luthar and I.B.S. Passi : Algebra (Volume 1) Groups (Narosa Publishing House)
2. I.N. Herstein : Topics in Algebra (Wiley-Eastern Ltd)
3. N.S. GopalaKrishnan : University Algebra (Wiley-Eastern Ltd)
4. Fraleigh : A First Course in Abstract Algebra
5. Dummit and Foote : Abstract Algebra (Wiley-Eastern Ltd)
6. Algebra, Artin.

Class : M.Sc I (Semester- I)

Paper Code: MAT4104

Paper : IV Title of Paper : Numerical Analysis

Credit : 4 No. of lectures: 64

A) Learning Objectives:

To solve problems numerically by various approximation methods

Use it solve problems in ODE and practical problems

B) Learning Outcome:

In real situations problems cannot be solve directly by available mathematical tools then use Numerical analysis to solve these problems with some error

TOPICS/CONTENTS:

1. **Root of Nonlinear Equations:** Introduction, Methods of Solution, Iterative methods, Evaluation of Polynomials, Bisection method, False Position method, Newton Raphson Method, Secant Method, Fixed Point Method, System of Nonlinear Equations, Roots of Polynomials
2. **Direct Solution of Linear Equations**: Existence of Solution, Solution by elimination, Basic Gauss Elimination method, Gauss elimination with pivoting, Gauss-Jordan Method, Triangular Factorization Methods, Round-off Errors and Refinement, Matrix Inversion Method
3. **Iterative Solution of Linear Equations:** Jacobi Iterative method, Gauss-Seidel Method, Convergence of Iteration Methods
4. **Curve Fitting Interpolation:** Polynomial forms, linear interpolation, Lagrange Interpolation Polynomial, Newton Interpolation Polynomial, Interpolation with equidistant points
5. **Numerical Differentiation:** Differentiating Continuous functions, Forward difference quotient, Central difference quotient, Error analysis
6. **Numerical Integration:** Newton-Cotes Methods, Trapezoidal Rule, Simpsons 1/3 rule, Simpsons 3/8 rule
7. **Numerical Solution of Ordinary Differential Equations:** Taylor Series Method, Euler's Method, Heun's Method, Polygon Method, Runge-Kutta Methods
8. **Boundary-value and Eigenvalue Problems:** Shooting Method, Finite Difference Method, Solving Eigenvalue Problems, Power method

Text Book: Numerical Methods, E Balagurusamy, McGraw Hill , Sections: 6.1-6.3, 6.5-6.10,7.1-7.8, 7.10,8.1-8.5,9.1-9.7,11.1,11.2,12.1-12.5,13.2-13.6,14.1-14.4,14.6

Reference Books:

1) S. S. Sastry, Introduction Methods of Numerical Analysis (4th Edition) Prentice
2) Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Prentice Hall 2007.
3) K .E. Atkinson: An Introduction to NumericalAnalysis.
4) J. I. Buchaman and P. R. Turner, Numerical Methods andAnalysis.
5) M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for scientific & Engineering Computation, 5th Edition New Age International Publication.

Class : M.Sc I (Semester- I)

Paper Code: MAT4105

Paper : V Title of Paper : Ordinary Differential Equations

Credit : 4 No. of lectures: 64

A) Learning Objectives:

- To understand theory of linear and nonlinear ODE
- To study methods to solve linear and nonlinear ODE
- To study applications of ODE

B) Learning Outcome:

Understanding of ODE and its applications to all Sciences as well as other real and practical problems

TOPICS/CONTENTS:

Review : General remarks on solutions of differentialequations, Families of curves, Orthogonal trajectories.

1. Second Order Linear Equations:

The general solution of the homogeneous equations, Use of a known solution to find another solution,Homogeneous equations with constant coefficients. Themethod of undetermined coefficients. The method of variation of parameters.

2. Qualitative properties of solutions of Ordinarydifferential equations of order two : Sturm Separation theorem.Normal form.Standard form, Sturm's comparison theorem.

3.Power Series Solutions and special functions:

Review of power series, Series solutions of first order equations,Second order linear equations. Ordinary points, Regular singular point, Indicial equations. GuassHypergeometric equation.The point at infinity.Legendre polynomials, properties of Legendrepolynomials, Bessel Functions, Properties of BesselFunctions.

4. Systems of First Order Equations:

General remarks on systems, Linear systems,Homogeneous linear system with constant coefficients.

5. The Existence and Uniqueness of solutions:

The method of successive approximations, Picardstheorem, Existence and uniqueness of Second order initial value problems.

Text Book:

G. F. Simmons : Differential Equations with applications and Historical notes (Tata - McGraw Hill).

Sections: 1 to 3, 7 to 11, 14 to 19 , 24 , 25, 26 to 32, 54 to 57, 68 to 70

Reference Books

1.G. Birkhoff and G.C. Rota : Ordinary differential equations.
(John Wiley and Sons)

2. S. G. Deo, V. Lakshmikantham, V. Raghvendra. Text book of Ordinary Differential Equations.Second edition.TataMc-Graw Hill.

3. E. A. Coddington : An Introduction to Ordinary Differential Equations
(Prentice Hall).

Class : M.Sc I (Semester- I)

Paper Code: MAT4106

Paper : VI

Title of Paper : Practical- Programming in C

Credit : 4 No. of lectures: 64

A) Learning Objectives:

- To understand basic programming in C
- To study mathematics using programming
- Use of Mathematics in programming

B) Learning Outcome:

To use programming to make useful software in industry and use of Mathematics in them makes them more reliable and user friendly

TOPICS/CONTENTS:

1. Introductory concepts in C
2. C Fundamentals
3. Operators and Expressions
4. Data input and outputs
5. Preparing and running a program
6. Control statements
7. Functions
8. Program Structures
9. Arrays
10. Pointers

Text Book:

YeshwantKanetkar, Let us C, BPB Publications

Reference Books :

i) Byron S. Gottfried, Programming with C, Schaum's Outline Series

ii) W.H.Press, S.A.Teukolsky et.al, Numerical recipes in C, The art of scientific computing

Class : M.Sc I (Semester- II)

Paper Code: MAT4201

Paper : I Title of Paper : Complex Analysis

Credit : 4 No. of lectures: 60

A) Learning Objectives:

To expose the students to basic and advance concepts in complexanalysis such as complex integration, singularities, maximum-modulus theorem

B) Learning Outcome:

Understanding of Complex Analysis and apply it to theoretical and practical problems

Topics/Contents:

Unit1- Preliminaries : The complex number system,The real numbers,The field of complex numbers,The complex plane,Polar representation and roots of complex numbers,Lines and Half planes in the complex plane,The extended plane and it's spherical representation.

(15 Lectures)

Unit2- Elementary Properties and Examples of Analytic Functions;Power Series,Analytic Functions,Analytic functions as mapping,Mobius transformation.

(10 Lectures)

Unit3- Complex Integration:Reemann-Stieltjes integration,Power series representation of analytic functions,Zeros of analytic function,The index of a closed curve,Cauchy's Theorem and Integral formula,The homotopic version of Cauchy's Theorem and simple connectivity, Counting zeroes;the Open Mapping Theorem, Goursat's Theorem.

(15 Lectures)

Unit 4-Singularities:Classification of singularities,Residues,The Argument Principle.

(10 Lectures)

Unit5-The Maximum Modulus Theorem: The Maximum Principle ,Schwarz's Lemma.

(10 Lectures)

Text Book: John B. Conway : Functions of one complex variable (Narosa Publishinghouse) Chapter: 1,3,4,5 & 6.

Reference Books:

1. Complex Analysis, E. Stein and Shakarchi, Overseas Press (India) Ltd., Princeton Lectures in Analysis.
2. Lars V. Ahlfors : Complex Analysis (McGrawHill)
3. Ruel V. Churchill / James Ward Brown : Complex Variables and Applications (McGraw Hill)

Class : M.Sc I (Semester- II)

Paper Code: MAT4202

Paper : II Title of Paper : Topology

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- Understanding of terms, definitions and theorems in topology
- Use of continuous functions, homeomorphism to understand topological spaces

B) Learning Outcome:

Use of topological concepts to solve problems in mathematics and real world.

Topics/Contents:

1. Countable and uncountable sets:
   Infinite sets, The axiom of choice, continuum hypothesis, Well ordered sets, The maximum principle.

   (6 Lectures)

2. Topological spaces and continuous functions:
   Basis for topology, Ordered topology, continuous functions, Product topology, Metric topology, Quotient topology.

   (14 Lectures)

3. Connectedness and compactness:
   Connected spaces, Components and local connectedness, Compact spaces, Limit point compactness, Local compactness, One point Compactification.

   (15 Lectures)

4. Countability and separation axioms:
   The countability axioms, Separation axioms, Normal spaces, The Urysohn lemma, The Urysohn metrization theorem (Statement only), The Tietze extension theorem (Statement only).

   (15 Lectures)

5. Tychonoff theorem, Completely regular spaces.

   (10 Lectures)

Text Book: *Topology A first Course*, J. R. Munkres, Prentice Hall of India.

(Sections: 1.7, 1.9, 1.10, 1.11, 2.1 to 2.11, 3.1 to 3.8, 4.1 to 4.4, 5.1 and 5.2)

Reference Books:

1. *General Topology*, J. L. Kelley, Springer Verlag.
2. *Topology*, J. Dugundji, Allyn and Bacon.
3. *General Topology*, S. Willard, Addison-Wesley Publishing Company.

Class : M.Sc I (Semester- II)

Paper Code: MAT4203

Paper : III Title of Paper : Rings and Modules

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- Importance of Rings as a fundamental object in Algebra
- Understanding concept of module as a generalization of vector spaces

B) Learning Outcome:

To understand rings and modules as a central concept in Algebra and their applications

Topics/Contents:

1. Rings [10 lecture]

Terminology, Rings of continuous functions, Matrix Ring,Polynomial Rings Power series Rings,Laurent Rings, Boolean Ring,Some Special Rings ,Direct Products Several Variables,Opposite Rings,Characteristic of a Ring.

2. Ideals [8 lecture]

Definitions, Maximal Ideals, Generators, Basic Properties of Ideals, Algebra of Ideals, Quotient Rings, Ideals in Quotient Rings, Local Rings

3. Homomorphism of Rings [12 lectures]

Definitions and Basic Properties, Fundamental Theorems, Endomorphism Rings, Field of fractions, Prime field

4. Factorization in Domains [15 lectures]

Division in Domains, Euclidean Domains, Principal Ideal Domains, Factorization Domains, Unique Factorization Domains, Eisenstein's Criterion.

5. Modules [15 lectures]

Definitions and Examples, Direct Sum, Free Modules, Vector Spaces, Quotient Module, Homomorphism, Simple Modules, Modules over PID's.

Text Book: *Rings and Modules*, C. Musili, Narosa Publishing House.

(Chapters:1 to 5)

Reference Books:

1. *Basic Abstract Algebra*, Bhattacharya, Nagpaul and Jain, Cambridge University Press.
2. *Rings and Modules*, C. Musili, Narosa Publishing House.
3. *Algebra II*, Luther and Passi, Narosa Publishing Hous
4. *Abstract Algebra* ,David S.Dummit and Richard M.Foote.

Class : M.Sc I (Semester- II)

Paper Code: MAT4204

Paper : IV Title of Paper : Linear Algebra

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- Understanding of vector spaces, subspaces and their properties
- Finding eigenvalues, eigenvectors and their applications
- Understanding of inner product spaces and bilinear forms

B) Learning Outcome:

Matrix representation of vector spaces, properties of vector spaces and their applications in real world.

Topics/Contents:

Revision – Matrices, Determinants, Polynomials. (Chapter 1 of the Text Book).

1) Vector Spaces , Subspaces , Basis and dimension , Linear Transformations , Quotient spaces , Direct sum , The matrix of a linear transformation .

(15 Lectures)

2) Canonical Forms , Eigenvalues and eigenvectors ,The minimal polynomial , Diagonalizable and triangulable operators , The Jordan Form , The Rational Form.

(15 Lectures)

3) Inner Product Spaces , Inner Products , Orthogonality , The adjoint of a linear Transformation , Unitary operators , Self adjoint and normal operators.

(15 Lectures)

4)Bilinear Forms , Definition and examples , The matrix of a bilinear form , Orthogonality , Classification of bilinear forms .

(15 Lectures)

Text Book: - Vivek Sahai, Vikas Bist : Linear Algebra (Narosa Publishing House).
Chapters : 2 to 5

Reference Books: i) Serge lang springer : Linear Algebra

ii) M. Artin : Algebra (Prentice - Hall of India private Ltd.)

iii) K. Hoffman and Ray Kunje : Linear Algebra (Prentice - Hall of India private Ltd.)

iv) S.Kumaresan :Linear Algebra (PHI Learning private Ltd.)

Class : M.Sc I (Semester- II)

Paper Code: MAT4205

Paper : V Title of Paper : Partial Differential Equations

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- Solving of linear partial differential equations using different methods
- Applications of partial differential equations in other subject and real world problems

B) Learning Outcome:

Solving of PDE and finding their applications

Topics/Contents:

1. First Order P.D.E. : Introduction, Charpit's Method, Jacobi's Method, Quasi-Linear Equations, Non-Linear First OrderP.D.E.

(25 Lectures)

2. Second Order P.D.E.: Introduction, One Dimensional Wave Equation, Laplace Equation, Boundary Value Problems, the Cauchy Problem, Dirichlet and Neumann Problem for different regions, Harnack's Theorem, Heat Conduction Problem, Duhamel's Principle, Classification of P.D.E. in the case of n-variables, Families of Equipotential Surfaces, Kelvin's InversionTheorem.

(35 Lectures)

Text Book

T. Amarnath : An Elementary Course in Partial Differential Equations (2nd edition) (Narosa Publishing House) [Chapters 1 and2].

Reference Books :

1. K. Sankara Rao: Introduction to partial differential equation, thirdedition.
2. W. E. Williams: Partial Differential equations (Clarendonpress-oxford)
3. E. T. Copson : Partial differential equations (Cambridge universitypress)
4. I.N. Sneddon: Elements of partial differential equations (Mc-Graw Hill bookcompany)

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Class : M.Sc. I (Semester- II)
Paper Code: MAT4206
Paper Code: MAT4206
Paper : VI Title of Paper : Practical: Programming in C++
Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To understand basic programming in C++
- To study mathematics using programming
- To understand object oriented programming

B) Learning Outcome:

For making useful software in industries, education and mathematics

Topics/Contents:

Introduction : What is object oriented programming? Why do we need object oriented.Programming characteristics of object-oriented languages C and C++.

C++ Programming basics : Output using cout. Directives. Input with cin. Type bool. The setw manipulator. Type conversions.

Functions : Returning values from functions. Reference arguments. Overloaded function. Inline function. Default arguments. Returning by reference.

Object and Classes : Making sense of core object concepts (Encapsulation, Abstraction, Polymorphism, Classes, Messages Association, Interfaces) Implementation of class in C++, C++ Objects as physical object, C++ object as data types constructor. Object as function arguments. The default copy constructor, returning object from function. Structures and classes. Classes objects and memory static class data. Const and classes. Arrays and string arrays fundamentals.

Arrays as class Member Data : Arrays of object, string, The standard C++ String class Operator overloading : Overloading unary operations. Overloading binary operators, data conversion, pitfalls of operators overloading and conversion keywords. Explicit and Mutable.

Inheritance : Concept of inheritance. Derived class and based class. Derived class constructors, member function, inheritance in the English distance class, class hierarchies, inheritance and graphics shapes, public and private inheritance,

aggregation : Classes within classes, inheritance and program development. Pointer : Addresses and pointers. The address of operator and pointer and arrays. Pointer and Faction pointer and C-types string.

Memory management : New and Delete, pointers to objects, debugging pointers.

Virtual Function : Virtual Function, friend function, Static function, Assignment and copy initialization, this pointer, dynamic type information. Streams and Files : Streams classes, Stream Errors, Disk File I/O with streams, file pointers, error handling in file I/O with member function, overloading the extraction and insertion operators, memory as a stream object, command line arguments, and printer output.

Templates and Exceptions : Function templates, Class templates Exceptions

Text Book: Let us C++, Yashwant Kanetkar

Reference Book:Object Oriented Programming in C++ , E. Balgurusamy