M. C. E. Society's
Abeda Inamdar Senior College
Of Arts, Science and Commerce, Camp, Pune-1
(Autonomous) Affiliated to SavitribaiPhule Pune University
NAAC accredited 'A' Grade

Two Year M.Sc. Degree Program in Mathematics
(Faculty of Science & Technology)

Syllabus for

M.Sc.-II (Mathematics)

Choice Based Credit System Syllabus
To be implemented from the academic year 2022-2023

Title of the Course: M.Sc (Mathematics)

Aims and Objectives of the Course

Sr. No.	Objectives
1.	To maintain an updated curriculum.
2.	To take care of fast development in the knowledge of mathematics
3.	To enhance the quality and standards of Mathematics Education.
4.	To provide a broad common framework, for exchange, mobility, and free dialogue across theIndian Mathematical and associated community.

Expected Course Specific Learning Outcome

Sr. No.	Objectives
1.	Students will have an aptitude to Study higher Mathematics and creative work in Mathematics.
2.	Students will equipped themselves with that part of Mathematics which is needed for various branches of Sciences or Humanities in which they have an aptitude for higher studies and original work.

Structure of M.Sc-I Mathematics Course

Sr. No.	Courses		Continuous Internal Evaluation (CIE) (Internal Marks)	End Semester Exam (External Marks)	Total Marks	Credits
	Semester-I	Semester-II				
1.	21SMMT111: Linear Algebra	21SMMT121: Complex Analysis	50	50	100	04
2.	21SMMT112: Real Analysis	21SMMT122: General Topology	50	50	100	04

3.	21SMMT113: GroupTheory	21SMMT123: Ring Theory	50	50	100	04
4.	21SMMT114: Advanced Calculus	21SMMT124: Advanced Numerical Analysis	50	50	100	04
5.	21SMMT115: Ordinary Differential Equations	21SMMT125: Partial Differential Equations	50	50	100	04
Extra credit course						
6.	21PGHUR11M: Human Rights	21PGCYS12M: Cyber Security	75		75	03

Structure of M.Sc-II Mathematics Course

Sr. No.	**Courses**		**Continuous Internal Evaluation (CIE) (Internal Marks)**	**End Semester Exam (External Marks)**	**Total Marks**	**Credits**
	Semester-III	**Semester-IV**				
Compulsory Courses						
1.	21SMMT231: Functional Analysis	21SMMT241: Fourier Series and Boundary Value Problems	50	50	100	04
2.	21SMMT232 : Field Theory	21SMMT242: Differential Geometry	50	50	100	04
3.	21SMMT233T: Programming with Python (Theory)	21SMMT243T: Introduction to Data Science (Theory)	25	25	50	02

4.	21SMMT233P: Programming with Python (Practical)	21SMMT243P: Introduction to Data Science (Practical)	25	25	50	02
Optional Courses (Any two of four courses)						
5.	21SMMT234A: Discrete Mathematics	21SMMT244A: Number Theory	50	50	100	04
6.	21SMMT234B: Probability and Stochastic Process	21SMMT244B: Statistical Inference	50	50	100	04
7.	21SMMT234C: Coding Theory	21SMMT244C: Integral Equations	50	50	100	04
8.	21SMMT234D: Students can choose one course from Swayam /NPTEL / E-Pathashala etc, if interested.	21SMMT244D: Students can choose one course from Swayam / NPTEL /E-Pathashala etc, if interested.	50	50	100	04
Extra Credit Courses						
9.	21PGHPE23M: Human Values & Professional Ethics	21DSDLT24M: Introduction to LaTeX and SageMath	75		75	03

For Continuous Internal Evaluation (CIE), evaluation of theory courses will be done continuously throughout the semester. CIE will be of 50% marks for CGPA papers.

CIE for 4 credits theory paper: It will be divided as follows:

SR. NO.	COMPONENTS		MARKS
1.	CIE I	Mid Semester examination	15
2.	CIE II	Two Class Test of 15 marks each (Best of 2)	15
3.	CIE III	One Presentation/Seminar/ MCQ Test	10
4.	CIE IV	Class Assignments / One group discussion / Open Book Test	10
		TOTAL	**50**

CIE for 4 credits Practical paper: It will be divided as follows:

SR. NO.	COMPONENTS		MARKS
1.	CIE I	Mock Practical Examination	30
2.	CIE II	Viva Voce	10
3.	CIE III	Journal / project report/ dissertation report completion and certification on time.	05
4.	CIE IV	Attendance	05
		TOTAL	**50**

Above components will also be followed for 2 credit theory and practical paper.

Syllabus:

Course/ Paper Title	**Functional Analysis**
Course Code	**21SMMT231**
Semester	**III**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Banach Spaces**	**25**
	1. The definition and some examples. 2. Continuous linear transformations. 3. The Hahn-Banach theorem. 4. The natural imbedding of N in N**. 5. The open mapping theorem.	5 5 5 5 5
Unit II	**Hilbert Spaces**	**25**
	1. The definition and some simple properties. 2. Orthogonal complements. 3. Orthonormal sets. 4. The conjugate space H*. 5. The adjoint of an operator. 6. Self-adjoint operators. 7. Normal and unitary operators. 8. Projections.	3 3 3 4 3 3 3 3

Unit III	Finite-Dimensional Spectral Theory	10
	1. Matrices. 2. Determinants and the spectrum of an operator. 3. The spectral theorem. 4. A survey of the situation.	2 3 3 2

Textbook:

G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw Hill.

Unit I: Chapter 9.

Unit II: Chapter 10.

Unit III: Chapter 11.

References:

1. Books:

1. B. V. Limaye, Functional Analysis, Wiley Eastern Ltd.

2. George Bachman, Lawrence Narici, Functional Analysis, Dover Publications.

3. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley, 1989.

4. S. Kesavan Functional Analysis, Hindustan Book Agency(India), ISBN 978-81-85931-87-6, ISBN 978-93-86279-42-2(eBook).

5. H. L. Royden Real Analysis, Third Edition, Prentice-Hall of india Private Limited, ISBN-8120309731.

2. Website:

1. https://nptel.ac.in/courses/111/105/111105037/
2. https://nptel.ac.in/courses/111/106/111106147/

Course/ Paper Title	**Field Theory**
Course Code	**21SMMT232**
Semester	**III**
No. of Credits	**04**

Unit No.	Title with Contents	No. of Lectures
Unit I	**Algebraic Extension of fields**	**20**
	1. Irreducible polynomials and Eisenstein criterion. 2. Adjunction of roots. 3. Algebraic extensions. 4. Algebraically closed fields.	5 5 5 5
Unit II	**Normal and separable extensions**	**15**
	1. Splitting fields. 2. Normal extensions. 3. Multiple roots. 4. Finite fields. 5. Separable extension.	3 3 3 3 3
Unit III	**Galois Theory**	**10**
	1. Automorphism groups and fixed fields. 2. Fundamental theorem of Galois theory. 3. Fundamental theorem of algebra.	3 4 3
Unit IV	**Applications of Galois theory to classical problems**	**15**
	1. Roots of unity and cyclotomic polynomials. 2. Cyclic extensions.	3 3

	3. Polynomials solvable by radicals. 4. Symmetric functions. 5. Ruler and compass constructions.	3 3 3

Textbook:

P. B. Bhattacharyya, S. K. Jain, S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, Second Edition.
Unit I: Chapter 15.

Unit II: Chapter 16.

Unit III: Chapter 17.

Unit IV: Chapter 18.

References:

1. Books:

1. D. Dummit, R. M. Foote, Abstract Algebra, 2nd Edition, Wiley Eastern Ltd.
2. T. A. Hungerford, Algebra, Graduate Texts in Mathematics, Vol. 73, Springer Verlag, 1980 (Indian Reprint 2004).
3. O. Zariski, P. Sammuel, Commutative Algebra, Vol. 1, Van Nostrand.
4. I. S. Luthar, I. B. S. Passi, Algebra, Vol. 4, Field Theory, Narosa Publishing House.
5. M. Artin, Algebra, Prentice Hall India, Second Edition.
6. Joseph Rotman, Galois Theory, Springer, 2nd Edition, ISBN-9780387985411.

2. Website:

1. https://nptel.ac.in/courses/111/101/111101117/
2. https://www.youtube.com/watch?v=G_BNxjRrQYI&list=PLyqSpQzTE6M94LuHxxu4OrViX4K45oH7

Course/ Paper Title	**Programming with Python(Theory)**
Course Code	**21SMMT233T**
Semester	**III**
No. of Credits	**02**

Unit No.	Title with Contents	No. of Lectures
Unit I	**Introduction to Python, Python Objects**	**02**
	1. Features of Python: Easy; Type and Run; Syntax; Mixing; Dynamic Typing; Built in Object Types; Numerous Libraries and Tools. 2. Chronology and Uses: Chronology; Uses. 3. Installation of Anaconda. 4. Basic Data Types Revisited: Fractions. 5. Strings. 6. Lists and Tuples: List; Tuples; Features of Tuples. 7. Introduction to NumPy. 8. Introduction to Pandas Data Structures: Series; DataFrame; Index Objects.	
Unit II	**Conditional Statements**	**02**
	1. if, if-else, and if-elif-else constructs. 2. The if-elif-else Ladder. 3. Logical Operators. 4. The Ternary Operator 5. The get Construct. 6. Examples.	
Unit III	**Looping**	**02**
	1. While. 2. Patterns. 3. Nesting and Applications of Loops in Lists.	

Unit IV	**Functions**	**03**
	1. Features of a functions: Modular Programming; Reusability of Code; Manageability. 2. Basic Terminology: Name of Functions; Arguments; Return Value. 3. Definition and Invocation: Working. 4. Type of Functions: Advantage of Arguments. 5. Implementing Search. 6. Scope. 7. Recursion: Rabbit Problem; Disadvantages of Using Recursion.	
Unit V	**Iterations, Generators, and Comprehensions**	**02**
	1. The Power of "For". 2. Iterators. 3. Defining an Iterable Object. 4. Generators. 5. Comprehensions.	
Unit VI	**File Handling**	**03**
	1. The File Handling Mechanism. 2. The Open Function and File Access Modes. 3. Python Functions for File Handling: The Essential Ones; The OS Methods; Miscellaneous Functions and File Attributes. 4. Command Line Arguments. 5. Implementation and Illustrations. 6. Reading and Writing Data in Text Format. 7. Binary Data Formats.	
Unit VII	**Strings**	**02**
	1. The Use of "For" and "While". 2. String Operators: The Concatenation Operator (+); The Replication Operator; The Membership Operator.	

	3. Functions for String Handling: len(); Capitalize(); find(); count; Endswith(); Encode; Decode;Miscellaneous Functions.	
Unit VIII	**Introduction to Object Oriented Paradigm**	**02**
	1. Creating New Types. 2. Attributes and Functions: Attributes; Functions. 3. Elements of Object- Oriented Programming: Class; Object; Encapsulation; Data Hiding; Inheritance; Polymorphism; Reusability.	
Unit IX	**Classes and Objects**	**03**
	1. Defining a Class. 2. Creating an Object. 3. Scope of Data Members. 4. Nesting. 5. Constructor. 6. Constructor Overloading. 7. Destructors.	
Unit X	**Inheritance**	**03**
	1. Introduction to Inheritance and Composition: Inheritance and Methods, Composition. 2. Inheritance: Importance and Types: Need of Inheritance; Types of Inheritance. 3. Methods: Bound Methods; Unbound Method; Methods are Callable Objects; The Importance and Usage of Super; Calling the Base Class Function Using Super. 4. Search in Inheritance Tree. 5. Class Interface and Abstract Classes.	
Unit XI	**Operator Overloading**	**03**
	1. _init_Revisited: Overloading _init_(Sort of). 2. Methods for Overloading Binary Operators.	

	3. Overloading the += Operator. 4. Overloading the > and < Operators. 5. Overloading the _boolEan_ Operators: Precedence of _bool_over _len_. 6. Destructors.	
Unit XII	**Exception Handling**	**03**
	1. Importance and Mechanism: An example of Try/Catch; Manually Raising Exception. 2. Built In Exceptions in Python: 3. The Process: Exception Handling: Try/Except; Raising Exceptions. 4. Crafting User Defined Exceptions. 5. An Example of Exception Handling.	

Textbook:

1. H. Bhasin: Python Basics, MERCURY LEARNING AND INFORMATION Dulles, Virginia Boston, Massachusetts New Delhi.

Unit I: Chapter-1: 1.2, 1.4, 1.5. Chapter 2: 2.2 to 2.4, Chapter-18.

Unit II: Chapter-3: 3.2 to 3.7.

Unit III: Chapter-4: 4.2 to 4.4.

Unit IV: Chapter-5: 5.2, to 5.8.

Unit V: Chapter-6: 6.2 to 6.6.

Unit VI: Chapter-7: 7.1, to 7.6.

Unit VII: Chapter-8: 8.2, to 8.4.

Unit VIII: Chapter-9: 9.2, 9.3, 9.4.

Unit IX: Chapter-10: 10.1, to 10.8.

Unit X: Chapter-11: 11.1to 11.5.

Unit XI: Chapter-12: 12.2, to 12.8.

Unit XII: Chapter-13: 13.2, to 13.6.

2. Wes McKinney, Python for Data Analysis, Second Edition, Published by O'Reilly Media.

Unit I: Chapter-5: Section 5.1.

Unit VI: Chapter-6: Sections 6.1, 6.2.

References:

1. Books:

1. Mark Lutz, Programming Python, Publication O'reilly.
2. Wesley J. Chun, Core Python Programming, Publication Prentice Hall.
3. Python: Notes for Professionals, Goalkicker.com, Free Programming books.
4. Excel Formulas Bible- Excel 2013/2016.

2. Website:

1. https://www.tutorialsteacher.com/python
2. https://www.tutorialspoint.com/python/index.htm

Best IDE TOOLS for Python:

Sr. No.	Tool	Version
1	Spyder	Version 5.2.1
2	Python 3.8.10	Python 3.8.10

Course/ Paper Title	**Programming with Python (Practical)**
Course Code	**21SMMT233P**
Semester	**III**
No. of Credits	**02**

Practical No.	Practical Name	No. of Hours
1	Introduction to Python	4
2	Data types and Operators in python	4
3	Data types and Operators in python	4
4	Iterations and Conditional Statements	4
5	Iterations and Conditional Statements	4
6	Python Functions, Modules & Packages	4
7	Python Functions, Modules & Packages	4
8	Files and Directories	4
9	Practical on NUMPY Library	4
10	Practical on Pandas Library	4
11	Practical on MATPLOTLIB	4
12	Practical on Reading and Writing Data from .csv, .xlsx file.	4

***** Three practical sessions for CIE.

Course/ Paper Title	**Discrete Mathematics**
Course Code	**21SMMT234A**
Semester	**III**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
	A] Graph Theory	
Unit I	**Topics in Graph Theory**	**15**
	1. Graphs; Graphs as Models; Matrices and Isomorphism; Decomposition and Special Graphs; Degree of a vertex; Counting and Bijections. 2. Paths, Cycles, Trails: Connection in Graphs; Bipartite Graphs; Eulerian Circuits; Hamiltonian Cycles. 3. Directed Graphs: Definition and Examples; Vertex Degrees; Eulerian Digraphs.	5 5 5
Unit II	**Trees**	**12**
	1. Trees: Properties of Trees; Distance in Trees and Graphs. 2. Enumeration of Trees: Spanning Trees in Graphs; Minimum Spanning Trees; Shortest Paths; Connectivity; Edge Connectivity. 3. Trees in Computer Science.	5 5 2
Unit III	**Matchings**	**3**
	1. Maximum Matchings; Hall's Matching Condition.	3
	B] Combinatorics	
Unit IV	**Basic Counting Principles**	**10**

	1. Two Basic Counting Principles. 2. Simple Arrangements and Selections. 3. Arrangements and Selections with Repetitions. 4. Distributions. 5. Binomial Identities.	2 2 2 2 2
Unit V	**Generating Functions**	**10**
	1. Generating Functions Models. 2. Calculating Coefficients of Generating Functions. 3. Partitions. 4. Exponential Generating Functions.	3 3 2 2
Unit VI	**Recurrence Relations**	**10**
	1. Recurrence Relations Models. 2. Solutions of Linear Recurrence Relations. 3. Counting with Venn Diagrams. 4. Inclusion-Exclusion Formula	3 3 2 2

Textbooks:

1. Douglas B. West: Introduction to Graph Theory; 2nd Edn; PHI Learning Pvt. Ltd.
   Unit I: Chapter 1: Sections 1.1, 1.2, 1.3 (Counting and Bijections), 1.4 (Definitions, Vertex Degrees, Eulerian Digraphs). Chapter 7: Section 7.2 (Hamiltonian Cycles).
   Unit II: Chapter 2: Section 2.1 (Properties of Trees; Distance), 2.2 (Enumeration of Trees; Spanning Trees), 2.3. Chapter 4: Sections 4.1 (Connectivity, Edge Connectivity).
   Unit III: Chapter 3: Section 3.1 (Maximum Matchings; Hall's Matching Condition).
2. Alan Tucker: Applied Combinatorics 6th Edn; Wiley India.
   Unit IV: Chapter 5: Sections 5.1 to 5.5.
   Unit V: Chapter 6: Sections 6.1 to 6.4.
   Unit VI: Chapter 7: Sections 7.1, 7.3. Chapter 8: Sections 8.1, 8.2.

References:

1. Books:

1. B. Kolman, R. Busby, S.C. Ross: Discrete Mathematical Structures, 6th Edn, Pearson Edn.

2. John Clark, D. A. Holton: A First Look at Graph Theory, World Scientific, 1991.

2. Website:

1. https://www.youtube.com/watch?v=E40r8DWgG40&list=PLEAYkSg4uSQ2fXcfrTGZdPuTmv98bnFY5
2. https://nptel.ac.in/courses/111/106/111106155/

Course/ Paper Title	**Probability and Introduction to Stochastic Process**
Course Code	**21SMMT234B**
Semester	**III**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Probability space**	**08**
	1. Introduction.	1
	2. Discrete probability space.	1
	3. Basic rules of probability.	1
	4. Conditional probability.	2
	5. Independence of events.	1
	6. Baye's formula	2
Unit II	**Discrete random variable**	**16**
	1. Definition.	1
	2. Probability distribution	1
	3. Expectation, variance, standard deviation of a discrete random variable.	2
	4. The Bernoulli random variable, the binomial random variable, the geometric random variable, the poisson random variable	4
	5. Joint probability distribution.	2
	6. Covariance and correlation coefficient.	1
	7. Independence of random variables.	2
	8. Conditional probability and conditional expectation.	3
Unit III	**Continuous random variables**	**15**

	1. Definition. 2. Probability distribution. 3. Expectation, variance, standard deviation of a continuous random variable. 4. The uniform random variable, exponential random variables, gamma random variables, normal random variables. 5. Joint probability density and probability distribution. 6. Covariance and correlation coefficient. 7. Independence of random variables.	1 2 2 4 2 2 2
Unit IV	**Central limit theorem**	**04**
	1. Markov's and Chebyshev's inequality for discrete random variables and continuous random variables. 2. Weak law of large numbers. 3. Central limit theorem.	2 1 1
Unit V	**Markov chains and countable state space**	**17**
	1. Definition 2. Examples. 3. Gambler's ruin problem, Ehrenfest model, random walk on Z, Z^2, Z^3 lattice. 4. Hitting times and hitting probabilities. 5. Recurrence and transcience. 6. States in a Markov chain 7. Stationary measure and distribution. 8. Convergence theorem for irreducible and aperiodic chains.	1 2 3 1 2 2 3 3

Textbook:

1. Sheldon H. Ross, Introduction to probability models, 9th edition, Academic Press.

Unit I: Chapter 1.

Unit II: Chapter 2, Chapter 3.

Unit III: Chapter 2 Chapter 3.

Unit IV: Chapter 2 Chapter 3.

2. Lecture notes of Prof. Manjunath Krishnapur.

Unit: V.

References:

1. Books:

1. Paul G. Hoel, Sidney C. Port, Charles .J. Stone, Introduction to probability theory.
2. Geoffreey R. Grimmet and David R. Stirzaker, Probablity and random processes, 4th Edition.

Course/ Paper Title	**Coding Theory**
Course Code	**21SMMT234C**
Semester	**III**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Error detection, correction and decoding**	**12**
	1. Introduction. 2. Communication channels. 3. Maximum likelihood decoding. 4. Hamming distance. 5. Nearest neighbour / minimum distance decoding. 6. Distance of a code.	2 2 2 2 2 2
Unit II	**Finite fields**	**12**
	1. Fields. 2. Polynomial rings. 3. Structure of finite fields. 4. Minimal polynomials**.**	3 3 3 3
Unit III	**Linear Codes**	**16**
	1. Vector spaces over finite fields. 2. Linear codes. 3. Hamming weight. 4. Bases for linear codes. 5. Generator matrix and parity–check matrix. 6. Equivalence of linear codes. 7. Encoding with a linear code.	2 2 2 2 2 2 2

	8. Decoding of linear codes: Cosets; Nearest neighbour decoding for linear codes; Syndrome decoding.	2
Unit IV	**Bounds in coding theory**	**08**
	1. The main coding theory problem. 2. Lower bounds: Sphere–covering bound; Gilbert–Varshamov bound. 3. Hamming bound and perfect codes: Binary Hamming codes; Golay codes. 4. Singleton bound and MDS codes.	2 2 2 2
Unit V	**Cyclic codes**	**08**
	1. Definitions. 2. Generator polynomials. 3. Generator and parity–check matrices. 4. Decoding of cyclic codes.	2 2 2 2
Unit VI	**Some special cyclic codes**	**04**
	1. BCH codes: Definitions; Parameters of BCH codes.	4

Textbook:

San Ling, Chaoping Xing, Coding Theory, A First Course; Cambridge University Press, 2004.

Chap 2: Sections 2.1 to 2.5

Chap 3: Sections 3.1, 3.2, 3.3, 3.4

Chap 4: Sections 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7,4.8

Chap 5: Sections 5.1, 5.2, 5.3, 5.4

Chap 7: Sections 7.1 to 7.4

Chap 8: Sections 8.1, 8.1.1, 8.1.2

References:

1. Books:

1. Raymod Hill, A First Course in Coding Theory, Oxford University Press.
2. Rudolf Lidl, Günther Pilz, Applied Abstract Algebra, Second Edition, Springer, Reprint 2004.

2. Website:

1. https://nptel.ac.in/courses/117/106/117106031/
2. https://nptel.ac.in/courses/108/104/108104092/

Course/ Paper Title	**Fourier Series and Boundary Value Problems**
Course Code	**21SMMT241**
Semester	**IV**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Fourier Series**	**10**
	1. Piecewise Continuous Functions, Fourier Cosine Series, Examples. 2. Fourier Sine Series, Examples. 3. Fourier Series, Examples. 4. Adaptations to Other Intervals.	3 3 2 2
Unit II	**Convergence of Fourier Series**	**10**
	1. One-Sided Derivatives, A Property of Fourier Coefficients. 2. Two Lemmas, A Fourier Theorem, Discussion of the Theorem and its Corollary, Convergence on Other Intervals, Lemma. 3. Absolute and Uniform Convergence of Fourier series, Differentiation of Fourier Series, Integration of Fourier Series.	3 4 3
Unit III	**The Fourier Method**	**08**
	1. Linear Operators, Principle of Superposition. 2. A Temperature Problem, A Vibrating String Problem.	4 4

Unit IV	**Boundary Value Problems**	**12**
	1. A Slab with Faces at Prescribed Temperatures, Related Problems, A Slab with Internally Generated Heat, Steady Temperatures in a Rectangular Plate. 2. Cylindrical Coordinates, String with Prescribed Initial Conditions, Resonance, Elastic Bar. 3. Double Fourier Series, Periodic Boundary Conditions.	4 4 4
Unit V	**Orthonormal Sets**	**10**
	1. Inner Products and Orthonormal Sets, Examples. 2. Generalized Fourier Series, Examples. 3. Best Approximation in the Mean, Bessel's Inequality and Parseval's Equation. 4. Application to Fourier Series.	2 3 3 2
Unit VI	**Sturm-Liouville Problems and Applications**	**10**
	1. Regular Sturm-Liouville Problems, Modifications, Orthogonality of Eigenfunctions, Real-Valued Eigenfunctions and Nonnegative Eigenvalues, Methods of solution. 2. Examples of Eigenfunctions Expansions, A Temperature Problem in Rectangular Coordinates , Another Problem, Other Coordinates. 3. Modification of the Method, Another Modification, A Vertically Hung Elastic Bar.	4 3 3

Textbook:

J.W. Brown, R.V. Churchill, Fourier Series and Boundary Value Problems, 7th Edition, McGraw Hill Education (India) Private Limited, New Delhi.

Unit I: Chapter 1.

Unit II: Chapter 2.

Unit III: Chapter 4.

Unit IV: Chapter 5.

Unit V: Chapter 7.

Unit VI: Chapter 8.

References:

1. Books:

1. Murray Spiegel, Fourier Analysis with Applications to Boundary Value Problems, Schaum's Outline Series, McGraw Hill.

2. Website:

1. https://www.youtube.com/watch?v=HoGNkZclxDU&list=PLs7oDAL8_ouJ5w8wCPtKnK2I09MlKC6kP
2. https://nptel.ac.in/courses/111/106/111106046/

Course/ Paper Title	**Differential Geometry**
Course Code	**21SMMT242**
Semester	**IV**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I		**15**
	1. Graphs and Level Sets. 2. Vector Fields. 3. The Tangent Space 4. Surfaces.	3 4 4 4
Unit II		**20**
	1. Vector Fields on Surfaces; Orientation. 2. The Gauss Map. 3. Geodesics. 4. Parallel Transport.	5 5 5 5
Unit III		**15**
	1. The Weingarten Map. 2. Curvature of Plane Curves. 3. Arc Length and Line Integrals.	5 5 5
Unit IV		**10**
	1. Curvature of Surfaces	10

Textbook:

John A. Thorpe, Elementary Topics in Differential Geometry, First Indian Reprint, Springer Publication, ISBN 978-81-8128-144-9.

Unit I: Chapter 1 to 4.

Unit II: Chapter 5 to 8.

Unit III: Chapter 9 to 11.

Unit IV: Chapter 12.

References:

1. Books:

1. Erwin Kryszig, Differential Geometry, Dover Publications Inc.
2. Christian Bar, Elementary Differential Geometry, Cambridge University Press.
3. Andrew Pressley, Elementary Differential Geometry, Springer.
4. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications Inc.

2. Website:

1. https://nptel.ac.in/courses/111/104/111104095/
2. https://www.youtube.com/watch?v=W9eFFO6pxWw&list=PL4fpys7KOcYg7TixVqy3F4ehhDNk97ZqL

Course/ Paper Title	**Introduction to Data Science (Theory)**
Course Code	**21SMMT243T**
Semester	**IV**
No. of Credits	**02**

Unit No.	Title with Contents	No. of Lectures
Unit I	**Data science in a big data world**	**04**
	1. Applications of data science	1
	2. Data sources- Social media, IoTdata, dataBase	1
	3. Types of Data: transactional data, time series data	1
	4. Multimedia data: images, Videos, textual data: pdfs, Docx	1
Unit II	**The data science process**	**05**
	1. Overview of the data science process.	1
	2. Cleaning data and transforming data	2
	3. Exploratory data analysis: data distribution, calculate quantile, IQR method, finding outliers, correlation	2
Unit III	**Machine learning**	**10**
	1. What is machine learning?	
	2. Training data and testing data	1
	3. Types of machine learning algorithms	1
	4. Supervised learning vs Unsupervised learning	1
	5. Regression: Linear regression, Logistic regression	1
	6. Classification: Decision Tree, Random Forest, SVM	1
	7. Clustering: k-Mean, DBscan	1
	8. Dimension reduction: PCA	1

Unit IV	**Handling large data on a single computer**	**04**
	1. General techniques for handling large volumes of data. 2. General programming tips for dealing with large data sets. 3. Case study predicting malicious URLs.	2 1 1
Unit IV	**Machine Learning Model accuracy metrics and errors**	**04**
	1. Confusion matrix, F1-score, ROC 2. MAPE, RMSE, accuracy	2 2
Unit V	**Applications of Machine Learning algorithm**	**05**
	1. Fraud detection 2. Prediction of rainfall	2 3
Unit VI	**Data visualization**	**03**
	1. Data visualization with Excel. Box plot, bar graph, Histogram, pie chart, line graph.	03

Textbook:

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Introducing Data Science, Manning Publications Co., 1st edition, 2016.

Unit I: Chapter 1: 1.1 to 1.4.

Unit II: Chapter 2: 2.1, 2.3 to 2.5.

Unit III: Chapter 3: 3.1 to 3.4.

Unit IV: Chapter 4: 4.2 to 4.4.

Unit V: Chapter 5: 5.1 to 5.2.

Unit VI: Chapter 8: 8.2, Chapter 9: 9.1.

2. Peters Morgan, Data Analysis from Scratch with Python, AI Sciences. ISBN-13: 978-1721942817.

Unit III: Chapters 10, 11, 12.

References:

1. Books:

1. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013.
2. Introduction to Machine Learning, Ethem Alpaydin, Third Edition 2018 PHI Learning Private Limited.

2. Website:

1. https://www.youtube.com/watch?v=fn1rKKNLuzk&list=PL15FRvx6P0OWTlNBS_93NHG2hIn9cynVT
2. https://www.youtube.com/watch?v=4SJ7bEILPJk&list=PLLy_2iUCG87CNafffzNZPVa9rW-QmOmEv

Course/ Paper Title	**Introduction to Data Science (Practical)**
Course Code	**21SMMT243P**
Semester	**IV**
No. of Credits	**02**

Practical No.	Practical Name	No. of Hours
1	Reading xlsx files, reading csv file through python	4
2	Writing csv and xlsx files with pandas with given column names and dates	4
3	Practical on NUMPY Library : maths functions walk through	4
4	Practical on NUMPY Library	4
5	Data manipulation with PANDAS library with Data Frame	4
6	Data manipulation with PANDAS library	4
7	Practical on Data cleaning, Find Outlier with IQR method	4
8	Practical on Data preparation and visualization	4
9	Practical on preparation and visualization	4
10	Practical on Machine Learning Algorithm: Linear Regression	4
11	Practical on Machine Learning Algorithm: Decision Tree Classification	4
12	Practical on Machine Learning: Confusion matrix, F1-Score	4

* Three practical sessions for CIE.

Open data set sites : https://data.gov.in/

Course/ Paper Title	**Number Theory**
Course Code	**21SMMT244A**
Semester	**IV**
No. of Credits	**04**

Unit No.	Title with Contents	No. of Lectures
Unit I	**Unique Factorization**	**12**
	1. Unique Factorization in Z, Unique Factorization in k[x]. 2. Unique Factorization in a Principal Ideal Domain. 3. The Rings Z[i] and Z[ω].	4 4 4
Unit II	**Congruence**	**12**
	1. Congruence in Z, The congruence $ax \equiv b(m)$. 2. The Chinese Remainder Theorem.	6 6
Unit III	**Quadratic Reciprocity**	**12**
	1. Quadratic Residues. 2. Quadratic Reciprocity.	6 6
Unit IV	**Some Functions of Number Theory**	**12**
	1. The Greatest Integer Function. 2. Arithmetic Functions. 3. The Möbius Inversion Formula.	4 4 4

Unit V	**Algebraic Numbers**	**12**
	1. Polynomials (Revision), Algebraic Numbers. 2. Algebraic Number Fields, Algebraic Integers. 3. Quadratic Fields, Units in Quadratic Fields. Primes in Quadratic Fields.	4 4 4

Textbook:

1) Kenneth Ireland, Michael Rosen**,** A Classical Introduction to Modern Number Theory, Springer, 4th Indian Reprint, 2013.

Unit I: Chapter 1: Arts 1 to 4.

Unit II: Chapter 3: Arts 1 to 4.

2) Ivan Niven, Herbert Zuckerman, Hugh Montgomery: An Introduction to Theory of Numbers, John Wiley and Sons, 5th Edition.

Unit III: Chapter 3: Arts 3.1 and 3.2.

Unit IV: Chapter 4: Arts 4.1 to 4.3.

Unit V: Chapter 9: Arts 9.1 to 9.7.

References:

1. Books:

1. G. Telang, Number Theory**,** Tata McGraw Hill.
2. M. B. Nathanson**,** Methods in Number Theory, GTM, Springer 3rd Indian Reprint, 2009.

2. Website:

1. https://nptel.ac.in/courses/111/101/111101137/
2. https://www.youtube.com/watch?v=F659tUopJMg&list=PLR3C3NSCyhZQLANHMMCiSrTg6OJcSMpzD

Course/ Paper Title	**Statistical Inference**
Course Code	**21SMMT244B**
Semester	**IV**
No. of Credits	**04**

Unit No	Title with Contents	No. of Lectures
Unit I	**Correlation and Regression Analysis**	**15**
	1. Introduction and Scatter Diagrams.	1
	2. Karl Pearson's Coefficient of Correlation.	2
	3. Spearmen's Rank correlation coefficient.	1
	4. Method of Concurrent Deviations.	1
	5. Interpretation of r and Probable Error.	1
	6. Linear Regression.	2
	7. Lines of Regression.	1
	8. Theorems on Regression Coefficients.	2
	9. Yule's Rule.	1
	10. Order of Regression coefficients.	1
	11. Statistical Inferences about the Regression Parameters.	2
Unit II	**Hypothesis Testing**	**13**
	1. Statistical Hypothesis, general concepts	2
	2. Testing a statistical hypothesis	2
	3. Types of errors in testing of hypothesis	2
	4. Level of significance	1
	5. Critical regions	1
	6. Use of p values for decision making	1
	7. Tests of significance for single mean (variance known)	1
	8. Tests of significance for single mean (variance unknown)	1

	9. Confidence interval estimation, Probability distribution	2
Unit III	**Chi square distribution**	**13**
	1. Introduction of Chi-square Distribution 2. Chi-square test for Goodness of Fit and its conditions for validity. 3. Chi-Square test for independence of attributes. 4. Degrees of Freedom. 5. Test for equality of several Proportions. 6. Chi-square test for population variance. 7. Applications of Chi-square Distribution.	1 2 2 2 2 2 2
Unit IV	**Small Sample Tests**	**12**
	1. Critical Values and Applications of t-distribution. 2. Confidence Interval for difference of two means. 3. Paired t-test for difference of two Means. 4. t-test for significance of an observed sample correlation coefficient. 5. F-distribution and its applications. 6. F-test for equality of population variances. 7. Relation between t, F and Chi-square Distributions.	2 2 2 2 1 1 2
Unit V	**Analysis of Variance (ANNOVA)**	**07**
	1. One-way analysis of variance 2. Two-way analysis of variance 3. The Kruskal-Wallis one-way analysis of variance by ranks 4. The Friedman two-way analysis of variance by ranks	1 2 2 2

Textbook:

1. Fundamentals of Statistics, by S. C. Gupta (Seventh Edition) (Chapters 8, 9, 13, 14, 16, 18, 19, 23)

References:

1. Books:

1. Introduction to Probability and Statistics for Engineers and Scientists, by Sheldon M. Ross (Fourth Edition).
2. Biostatistics, A Foundation for Analysis in Health Sciences, by Wayne W. Daniel (Eighth Edition, Wiley Publications).
3. Mathematical Statistics, by Parimal Mukhopadhyay.
4. Statistics for the Life Sciences, by M. Samules, J. Witmer and A. Schaffner (Fifth Edition, Pearson India).

2. Website:

1. https://nptel.ac.in/courses/111/105/111105124/
2. https://nptel.ac.in/courses/111/105/111105043/

Course/ Paper Title	**Integral Equations**
Course Code	**21SMMT244C**
Semester	**IV**
No. of Credits	**04**

Unit No.	Title with Contents	No. of Lectures
Unit I	**Introductory Concepts**	**12**
	1. Definitions.	2
	2. Classification of Linear Integral Equations.	2
	3. Solution of an Integral Equation.	2
	4. Converting Volterra Equation to ODE.	2
	5. Converting IVP to Volterra Equation.	2
	6. Converting BVP to Fredholm Equation.	2
Unit II	**Fredholm Integral Equations**	**12**
	1. Introduction.	1
	2. The Decomposition Method.	2
	3. The Direct Computation Method.	2
	4. The Successive Approximation Method.	2
	5. The Method of Successive Substitutions.	2
	6. Comparison between Alternative Methods.	1
	7. Homogeneous Fredholm Equations.	2
Unit III	**Volterra Integral Equations**	**14**
	1. Introduction.	1
	2. The Decomposition Method.	2
	3. The Series Solution Method.	2
	4. Converting Volterra Equation to IVP.	2
	5. The Successive Approximation Method.	2
	6. The Method of Successive Substitutions.	2

	7. Comparison between Alternative Methods. 8. Volterra Equation of the First Kind.	1 2
Unit IV	**Integro-Differential Equations**	**10**
	1. Fredholm Integro-Differential Equations. 2. Volterra Integro-Differential Equations.	5 5
Unit V	**Singular Integral Equations**	**06**
	1. Definitions. 2. Abel's Problem. 3. The Weakly-Singular Volterra Equations.	2 2 2
Unit VI	**Integral Transform Methods**	**06**
	1. Introduction. 2. Fourier Transform. 3. Laplace Transform. 4. Applications to Volterra Integral Equations with Convolution-Type Kernels. 5. Examples.	1 1 1 1 2

Textbook:

1. Abul-Majid Wazwaz, A First Course In Integral Equations, World Scientific Publications, 1997.

Unit I: Chapter 1.

Unit II: Chapter 2.

Unit III: Chapter 3.

Unit IV: Chapter 4 and 5.

Unit V: Chapter 6: Sections 6.1, 6.2, 6.3, 6.4.

2. Ram P. Kanwal, Linear Integral Equations, 2nd Edition, Springer Science+Business Media, LLC.

Unit VI: Chapter 9: Sections 9.1, 9.2, 9.3, 9.4, 9.5.

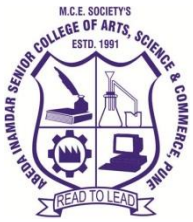
References:

1. Books:

1. Rainer Kress, Linear Integral Equations, 3rd Edition, Springer.
2. Abdul J. Jerri, Introduction to Integral Equations with Applications, Wiley-Interscience; 2nd Edition (September 3, 1999).

2. Website:

1. https://www.youtube.com/watch?v=GiPOQC5nYMs&list=PL521C2DFD15FF568
2. https://nptel.ac.in/courses/111/107/111107103/



M. C. E. Society's

Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1

(Autonomous) Affiliated to SavitribaiPhule Pune University

NAAC accredited 'A' Grade

Faculty of Science & Technology

Syllabus of

Skill Development Course on LaTeX and SageMath (Non CGPA)

Choice Based Credit System Syllabus

To be implemented from the academic year 2022-2023

Mode of Assesment: Evaluation will be done continuously. There will be two Practical test of 25 marks each, two assignments of 10 marks and 5 marks for journal.

Details of Syllabus:

Course/ Paper Title	Introduction to LaTeX and SageMath
Course Code	21DSDLT24M
Semester	IV
No. of Credits	3

Syllabus

Unit No	Title with Contents	No. of Lectures
Unit I	**Introduction to LaTeX**	**02**
	1.1 Definition and application of LaTeX, Preparation and Compilation of LaTeX input file	01
	1.2 LaTeX Syntax and Keyboard Characters in LaTeX	01
Unit II	**Formatting Words, Lines, and Paragraphs**	**04**
	2.1 Text and Math Mode Fonts, Emphasized and Colored Fonts.	01
	2.2. Labeling and Referring Numbered Items.	01
	2.3. Texts Alignment and Quoted text.	01
	2.4. New Lines and Paragraphs.	01
Unit III	**Listing and Table Preparation**	**06**
	3.1 Listing Texts.	02
	3.2 Table Through the tabular Environment and tabularx Enviroment.	01
	3.3 Vertical Positioning of Tables, Sideways (Rotated) Texts in Tables.	01
	3.4 Merging Rows and Columns of Tables.	02

Unit IV	**Equation Writing**	**03**
	4.1 Basic Mathematical Notations and Delimiters. 4.2 Mathematical Operators, Mathematical Expression in Text- mode. 4.3 Simple Equations and Array of Equations.	01 01 01
Unit V	**Figure Insertion and Figure Drawing**	**03**
	5.1 Commands and Environment for Inserting Figures. 5.2 Inserting a simple figure. 5.3 tikz package for drawing figures.	01 01 01
Unit VI	**Presentation Using Beamer**	**03**
	6.1 Frames and Sectional Units in Presentation. 6.2 Presentation Structure. 6.3 Appearance of a Presentation (Beamer Themes).	01 01 01
Unit VII	**Getting Started with SageMath**	**03**
	7.1 Introduction and Installation of SageMath. 7.2 Exploring integers, solving equations in SageMath. 7.3 2D and 3D plotting in SageMath.	01 01 01
Unit VIII	**Calculus with SageMath**	**06**
	8.1 Calculus of one variable with SageMath. 8.2 Applications of derivatives. 8.3 Applications of Integrals. 8.4 Partial Derivatives and gradients, jacobians. 8.5 Local maximum-minimum.	01 01 01 01 01 01

	8.6 Application of local maximum and minimum	
Unit IX	**Linear Algebra with SageMath**	**07**
	9.1 RREF and Solving system of linear Equations. 9.2 Vector spaces in SageMath. 9.3 Linear Transformations with SageMath. 9.4 Eigenvalues and Eigenvectors with SageMath. 9.3 Inner Product Spaces in SageMath. 9.4 Gram-Schmidt Process.	01 01 01 01 01 02
Unit X	**Numerical Analysis with SageMath**	**08**
	10.1 QR- Factorization, Singular Value Decomposition (SVD). 10.2 Numerical Solution of algebraic equations. 10.3 Numerical Solutions of system linear equations. 10.4 Interpolations. 10.5 Numerical Integration.	02 02 01 01 02

Text book: **LaTeX**

1. Dilip Datta, LaTeX in 24 Hours, A Practical Guide for Scientific Writing, Springer

Unit I: Chapter-1.

Unit II: Chapter-2, Chapter-3 : 3.1, 3.2, 3.3, 3.4, 3.5.

Unit III: Chapter -6: 6.1, Chapter-7: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7.

Unit IV: Chapter-11: 11.1,11.2, 11.3, 11.4 ,11.5.

Unit V: Chapter-9: 9.1, 9.2.

Unit VI: Chapter 21: 21.1, 21.2, 21.3, 21.4.

2. Zofia Walczak, Graphics in LATEX using TikZ.

Reference Books: SageMath

1. Mathematical Computation with Sage by Paul Zimmermann available from on http://www.sagemath.org.

2. An Introduction to SAGE Programming: With Applications to SAGE Interacts for Numerical Methods by Razvan A Mezei, Springer.

3. Sage for Undergraduates, Gregory V. Bard.