Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Autonomous
Course Structure for B.Sc. Mathematics (w.e.f. 2022-23)

F. Y. B. Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
I	USMT111	Algebra	2	36
	USMT112	Calculus-I	2	36
	USMT113	Practical based on USMT111 and USMT112	2	48
II	USMT121	Geometry	2	36
	USMT122	Calculus-II	2	36
	USMT123	Practical based on USMT121 and USMT122	2	48

S. Y. B. Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
III	USMT231	Calculus of Several Variables	3	48
	USMT232	Laplace Transform & Fourier Series	3	48
	USMT233	Practical based on USMT231 and USMT232	2	48
IV	USMT241	Vector Calculus	3	48
	USMT242	Linear Algebra	3	48
	USMT243	Practical based on USMT241 and USMT242	2	48

T.Y.B.Sc Mathematics

Semester	Course Code	Title of Course	No. of Credits	No. of Lectures
V	USMT351	Metric Spaces	3	48
	USMT352	Real Analysis I	3	48
	USMT353	Group Theory	3	48
	USMT354	Ordinary Differential Equation	3	48
	USMT355	Number Theory	3	48
	USMT356(A)	Operation Research	3	48
	USMT356(B)	C Programming	3	48
	USMT357	Practical based on USMT351 and USMT352	2	48
	USMT358	Practical based on USMT353 and USMT354	2	48
	USMT359	Practical based on USMT355 and USMT356	2	48
VI	USMT361	Complex Analysis	3	48
	USMT362	Real Analysis II	3	48
	USMT363	Ring Theory	3	48
	USMT364	Partial Differential Equation	3	48

	USMT365	Lebesgue Integration	3	48
	USMT366(A)	Optimization Techniques	3	48
	USMT366(B)	Python Programming	3	48
	USMT367	Practical based on USMT361, USMT362, and USMT363	2	48
	USMT368	Practical based on USMT364, USMT365, and USMT366	2	48
	USMT369	Mathematics Project	2	48

Equivalence of the old syllabus with the new syllabus

Old Course		New Course	
MAT 1101	Algebra	USMT111	Algebra
MAT 1102	Calculus-I	USMT112	Calculus-I
MAT 1103	Practical based on MAT 1101 and MAT 1102	USMT113	Practical based on USMT111 and USMT112

Academic Year 2022-23

Class: F.Y.B.Sc. (Semester – I)
Course Code: USMT 111
Course: I **Title of the Course:** Algebra
Credit: 2 **No. of Lectures:** 36

TOPICS/CONTENTS:

Unit 1: Sets, Relations and Functions [*8 Lectures*]

1.1 Sets and basic operations on sets
1.2 Relations, Equivalence relations, Equivalence classes and Partition of sets.
1.3 Functions, Types of functions, Inverse of a function, Composition of functions.

Unit 2: Divisibility theory in the integers [*10 Lectures*]

2.1 Mathematical induction: Well-Ordering Principle.
2.2 The division algorithm
2.3 The greatest common divisor
2.4 The Euclidean algorithm

Unit 3: Primes and theory of congruences [*8 Lectures*]

3.1 The fundamental theorem of arithmetic
3.2 Basic properties of congruences
3.3 Fermat's theorem.
3.4 Euler's phi-function (Definition and examples only) and Euler's theorem.

Unit 4: Complex Numbers [*10 Lectures*]

4.1 Sum and product
4.2 Basic algebraic properties
4.3 Moduli
4.4 Complex conjugate
4.5 Exponential form
4.6 Product and powers in exponential form
4.7 Arguments of product and quotients
4.8 Roots of complex numbers
4.9 Regions in the complex plane

Text Books:

1. Ajit Kumar, S. Kumaresan and Bhaba Kumar Sarma, *A Foundation Course in Mathematics,* Narosa Publication House, 2018.
Unit 1 - Sections: 2.1 to 2.5, 3.1 to 3.6, 4.1 to 4.4.

2. David M. Burton, *Elementary Number Theory,* Tata McGraw Hill, 7th Edition, 2012.
   Unit 2 - Sections: 1.1, 2.2 to 2.4; **Unit 3 -** Sections: 3.1, 4.2, 5.2, 7.2 and 7.3.
3. Ruel V. Churchill, James W. Brown, *Complex Variables and Applications,* McGraw-Hill, Eighth Edition.
   Unit 4 - Chapter 1.

Reference Books:

1. S. K. Shah and S. C. Garg, *Textbook of Algebra*, Vikas Publishing House Pvt. Ltd.
2. Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, Tata McGraw Hill.
3. Seymour Lipschutz, *Set Theory and Related Topics*, Schqum's Ountline Series.
4. Robin Wilson, *Number Theory: A very short introduction*, Oxford University Press.
5. Sudarsan Nanda, *Number Theory*, Allied Publishers Pvt. Ltd.
6. Verity Carr, *Complex Numbers: Made Simple*, Made Simple Books.
7. Robert G. Bartle and Donald R. Sherbert, *Introduction to Real Analysis*, John Wiley & Sons.

Class: F.Y. B. Sc. (Semester- I) **Title of Course :** Calculus I
Course Code: USMT112 **Credit:** 2
Course: II **No. of lectures:** 36

Unit 1: Real Numbers **(06 Lectures)**

1.1 The Algebriac and Order Properties of R: Algebraic properties of R, Order properties of R, Well-Ordering Property of N. Arithmetic mean-Geometric mean inequality, Bernoulli's inequality. (Revision: essential properties should be revised with illustrative examples)

1.2 Absolute Value and the Real Line: Absolute value function and its properties, triangle inequality and its consequences, neighbourhood of a point on real line.

1.3 The Completeness Property of R: Definitions of Upper bound, Lower bound, supermom, infimum of subsets of R, completeness property of R.

1.4 Applications of the Supremum Property: Archimedean property and its consequences, The density theorem (without proof).

Unit 2. Sequences **(10 Lectures)**

2.1 Sequences and Their Limits: Definition and examples of sequences of real numbers, Definition of limit of sequence and uniqueness of limit, Examples on limit of sequence.

2.2 Limits Theorems: Definition of bounded sequence, Every convergent sequence is bounded, Algebra of limits.

2.3 Monotone Sequences: Definition and examples of monotone sequences, Monotone convergence theorem and examples.

2.4 Subsequences and Bolzano -Wierstrass Theorem: Definition of subsequence and examples, Divergence criteria, Monotone Subsequence theorem (without proof), Bolzano - Wierstrass theorem (first proof).

Unit 3. Limits **(08 Lectures)**

3.1 Functions and their Graphs Functions, domain and range, graphs of functions, representing a function numerically, Vertical line test, Piecewise defined functions, increasing and decreasing functions, even and odd functions symmetry, common functions

3.2 Limits of Functions: Definition of cluster point and examples, definition of limit of a function, sequential criterion for limits, divergence criteria.

3.3 Limit Theorems: Algebra of limits (proofs using sequential criterion) ,Squeeze theoerem.

3.4 Some extension of limit concepts: one-sided limits, infinite limits (without proof) .

Unit 4: Continuity **(12 Lectures)**

4.1 Continuous Functions: Definition of continuous function at a point , sequential criterion for continuity, Divergence criterion, combination of continuous functions.

4.2 Continuous Functions on Intervals: Properties of continuous functions on an interval, Boundedness theorem (without proof), The minimum -maximum theorem(without proof), Location of root theorem (Without proof), Bolzano's intermediate value theorem. Continuous function maps closed bounded interval to closed bounded interval, Preservation of interval theorem.

Textbooks:

1. R.G. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons Inc, Fourth Edition.
Unit 1: Chapter 2: Sec 2.1 (2.1.1 to 2.1.13), Sec. 2.2(2.2.1 to 2.2.9), 2.3, 2.4(2.4.1, 2.4.3 to 2.4.6, 2.4.8, 2.4.9).
Unit 2: Chapter 3: Sec. 3.1(3.1.1 to 3.1.7, 3.1.10, 3.1.11), Sec. 3.2(3.2.1 to 3.2.11), Sec. 3.3(3.3.1, 3.3.4), Sec. 3.4 (3.4.1 to 3.4.3, 3.4.5 to 3.4.8).
Unit 3: Chapter 4: Sec. 4.1(4.1.1, 4.1.3 to 4.1.9), Sec. 4.2(4.2.1 to 4.2.8), Sec. 4.3 (4.3.1 to 4.3.9). **Unit 4:** Chapter 5: Sec. 5.1, Sec. 5.2, Sec 5.3 (5.3.1 to 5.3.5, 5.3.7 to 5.3.10).

2. J. Hass, C. Heil, and M. Weir, *Thomas Calculus*, Thirteenth Edition, Pearson Publication.
Unit 3: Text book-2: Chapter 1: Sec. 1.1.

Reference books:

1. William F.Trench, *Introduction to Real analysis*, Free edition, 2010.
2. Ron Larson, Bruce Edwards*, Calculus of a single variable*, tenth edition.
3. Kenneth A. Ross, *Elementary Analysis, The Theory of Calculus*, Springer Publication, second edition.
4 Marvin L. Bittinger, David J. Ellenbogen and Scott A. Surgent *Calculus and its Applications*, Addison Wesley, tenth edition.

Class: F.Y. B. Sc. (Semester- I)

Title of Course: Practical Based on USMT111 & USMT112

Course Code: USMT113

Credit: 2

Course: III

No. of lectures: 48

Title of Experiments:

Algebra:

1. Problems on Sets, Relations, and Functions
2. Problems on Divisibility theory in the integers
3. Problems on Primes and the theory of congruences
4. Problems on Complex Numbers
5. Problems on Matrices
6. Algebra using Maxima Software

Calculus I:

1. Problems on Real Numbers
2. Problems on Sequences
3. Problems on Limits
4. Problems on Continuity
5. Real numbers and sequences using Maxima Software
6. Limits and continuity using Maxima Software

Class: F.Y.B.Sc. (Semester – I)
Course Code: USMT111
Course: 1 **Title of the Course:** Algebra
Credit: 2 **No. of Lectures:** 36

A) Course Objectives:

1. Define and comprehend the basic concepts of sets, including set notation, set operations (union, intersection, complement), subsets, power sets, and the cardinality of sets.
2. Analyze and differentiate between relations and functions, exploring various types of relations (equivalence, partial orders) and functions (injective, surjective, bijective).
3. Apply the knowledge of sets, relations, and functions to model real-world problems, emphasizing their significance in computer science, mathematics, social sciences, and other domains.
4. To comprehend the foundational concepts of divisibility within integers, including prime factorization, divisibility rules, and their applications.
5. To enable students to apply the Euclidean Algorithm effectively in finding the greatest common divisor (GCD) of integers and its applications in solving problems related to divisibility.
6. To introduce the theory of congruences, modular arithmetic, and residue classes, enabling students to solve problems involving congruences and understand their applications.
7. Understand the fundamental concepts of complex numbers, including their representation as points in the Cartesian plane, exponential form, and De Moivre's Theorem.
8. Apply complex number techniques to solve mathematical problems involving polar and exponential representations, as well as utilize De Moivre's Theorem for simplifying complex calculations.

B) Course Outcomes:

1. Students will demonstrate proficiency in performing set operations, manipulating sets, understanding set properties, and solving problems involving sets and their elements.
2. Students will be able to analyze various relations and functions, identify their properties, determine their types, and apply this knowledge to solve problems in different contexts, fostering critical thinking and problem-solving skills.
3. Students will be able to analyze and determine divisibility properties of integers, apply prime factorization, and use divisibility rules to solve problems effectively.
4. Students will demonstrate proficiency in applying the Euclidean Algorithm to compute the greatest common divisor of integers, and use it to solve problems involving divisibility, linear Diophantine equations, and related topics.
5. Students will be able to solve problems using congruences, manipulate congruence classes, apply modular arithmetic principles, and use these concepts to solve problems related to divisibility and number theory.
6. Ability to graphically represent complex numbers in the Cartesian plane, understanding their geometric interpretation and relationships between real and imaginary parts.

7. Proficiency in manipulating complex numbers in exponential form, utilizing De Moivre's Theorem to simplify and compute powers and roots, and solving problems involving complex arithmetic with ease and accuracy.

Mapping of Program Outcomes with Course Outcomes

Class: FYBSc (Sem I) **Subject:** Mathematics
Course: Algebra **Course Code:** USMT111
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	2	2				1			1
CO 2	3	2			1				1
CO 3	2	2			1				
CO 4	2	3		1					1
CO 5	3	3		1	1				1
CO 6	2	2							
CO 7	2	3							

Justification for the mapping

PO1: Disciplinary Knowledge
CO1: Understanding sets and set operations fosters logical reasoning and problem-solving skills crucial in various disciplines, enhancing students' capacity to analyze and manipulate data efficiently.
CO2: Studying relations and functions cultivates critical thinking by enabling students to discern properties, types, and applications, empowering them to solve problems across diverse contexts within disciplinary knowledge.
CO3: Understanding divisibility properties of integers, prime factorization, and divisibility rules equips students with essential tools to solve diverse mathematical problems efficiently.
CO4: Mastering the Euclidean Algorithm enables students to efficiently find the greatest common divisor, unlocking solutions for various mathematical problems encompassing divisibility, linear Diophantine equations, and related concepts.
CO5: Understanding congruences and modular arithmetic equips students with powerful tools to solve diverse mathematical problems in divisibility and number theory.
CO6: The graphical representation of complex numbers in the Cartesian plane provides a visual understanding of their geometric interpretation, revealing the interplay between their real and imaginary parts crucial for comprehending their mathematical relationships.

CO7: Proficiency in manipulating complex numbers through De Moivre's Theorem enables precise simplification, computation of powers/roots, and facilitates accurate problem-solving in complex arithmetic within various disciplines.

PO2: Critical Thinking and Problem Solving

CO1: Understanding set operations and properties fosters logical reasoning and enhances problem-solving skills essential for critical thinking in various domains.
CO2: Studying relations and functions cultivates critical thinking and problem-solving skills by enabling students to discern properties, types, and applications across diverse contexts.
CO3: Students will develop analytical skills by mastering divisibility properties, prime factorization, and divisibility rules, enabling effective problem-solving in critical thinking scenarios.
CO4: Mastering the Euclidean Algorithm fosters problem-solving skills essential for tackling complex mathematical scenarios involving divisibility, Diophantine equations, and related concepts.
CO5: Understanding congruences and modular arithmetic principles equips students with powerful problem-solving tools to tackle divisibility and number theory, fostering critical thinking through mathematical reasoning and manipulation.
CO6: Graphically representing complex numbers in the Cartesian plane allows for a visual understanding of their geometric interpretation, aiding in critical thinking by revealing relationships between real and imaginary parts through their spatial orientation and magnitude.
CO7: Proficiency in manipulating complex numbers through De Moivre's Theorem enhances problem-solving by simplifying computations, facilitating efficient calculation of powers/roots, and ensuring accurate solutions in complex arithmetic challenges.

PO4: Research-related skills and Scientific temper

CO4: The Euclidean Algorithm facilitates efficient determination of greatest common divisors, crucial for solving problems in divisibility, Diophantine equations, and related mathematical concepts, fostering research-related skills and a scientific mindset.
CO5: Understanding congruences and modular arithmetic equips students with problem-solving abilities crucial in research by enabling them to analyze patterns, manipulate classes, and apply these concepts to tackle problems in divisibility and number theory, fostering scientific temper.

PO5: Trans-disciplinary Knowledge

CO2: Analyzing relations and functions cultivates critical thinking by enabling students to recognize patterns, properties, and types, empowering problem-solving across diverse disciplines.
CO3: Analyzing divisibility properties enhances problem-solving by applying prime factorization and rules, fostering a trans-disciplinary approach to mathematics.
CO5: Understanding congruences and modular arithmetic empowers students to solve diverse problems across disciplines by applying these fundamental principles to address challenges in divisibility, number theory, and problem-solving.

PO6: Personal and Professional Competence

CO1: Proficiency in set operations cultivates analytical thinking essential for problem-solving across various personal and professional domains.

PO9: Self-directed and Life-long Learning

CO1: Understanding set operations and properties cultivates logical thinking and problem-solving skills, crucial for self-directed learning across diverse disciplines and lifelong problem-solving.

CO2: Studying relations and functions cultivates critical thinking by enabling students to discern properties, classify types, and solve problems across diverse contexts, fostering self-directed learning and lifelong problem-solving skills.

CO4: The Euclidean Algorithm equips students with a versatile problem-solving tool for understanding divisibility, linear Diophantine equations, and related mathematical concepts, fostering self-directed and lifelong learning.

CO5: Understanding congruences and modular arithmetic equips students with problem-solving skills in various mathematical contexts, fostering self-directed and life-long learning through their applicability in problem-solving, divisibility, and number theory.

Class: F.Y.B.Sc.

Paper Code: USMT112

Title of Paper: Calculus-I

Course Outcomes:

CO1:Students will able to classify real numbers and recognize different properties that exits with real numbers.
CO2:Students will able to understand the concept of supremum and infimum and their applications.
CO3:Students will able to apply definition of continuity to pure and applied problems.
CO4:Students will able to draw the graphs of algebraic and transcendental functions considering limits and continuity.
CO5:Students will able to understand the definition of limits and convergence in the context of sequences of real numbers.
CO6:Students will able to prove statements involving convergence arguments.
CO7:Students will apply limit of sequence , limit and continuity of a function concept in physical,chemical, and biological sciences.

Mapping of Program Outcomes with Course Outcomes

Class: F.Y.B.Sc. (Sem I) **Subject:** Mathematics

Course: Calculus-I **Course Code:** USMT112

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3= strong or direct relation.

	Programme Outcomes(POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2							1
CO 2	3	2		2	2				1
CO 3	3	2		2					1
CO 4	3	2			2				1
CO 5	3	2		2	2				1
CO 6	3	2		2					1
CO 7	3	2		2	2	2			1

Justification for the mapping

PO 1: Disciplinary Knowledge:

All of these course outcomes (COs) contribute to the development of students disciplinary knowledge in mathematics.For example, CO1,CO2,CO3,CO4,CO5,CO6 requires student to develop deep learning of real number system, sequence,limit of a function and continuity.CO7 requires students to apply the concepts of calculus in many fields like engineering,statistics ,biology and computer science.

PO2:Critical Thinking and Problem Solving:

All of these course outcomes (COs) contribute to the development of students critical thinking and problem solving. Stratergies.For example, CO1, CO2 ,CO4, CO5 requires students to think critically and apply these to solve complex problems in various filed like engineering and physics. CO3,CO6 and CO7 requires to apply and construct logical proofs to solve real world problems.

PO4: Research-related skills and Scientific temper:

CO2,CO3,CO5,CO6,CO7 contribute to students research related skills.Students will able to apply the tools of calculus to various real world problems in different areas.

PO5:Trans-disciplinary Knowledge:

CO2,CO4,CO5,CO7 requires to students to apply mathematical concept such as convergence of sequence, behaviour of function to solve complex problems. These concepts are useful in many different fields such as Physics,engineering ,chemistry and economics.

PO6:Personal and professional competence:

The course outcome CO7contrbute to demonstrate the ability of students to apply mathematical concept such as limit of sequence, convergence in practical manner. This ability is essential for personal and professional development.

PO9:Self-directed and Life-long learning:

All of these COs contribute to demonstrate the ability of students to apply the concept of real numbers ,sequences in practical context. This ability will enable them to continue learning and developing skills throughout life.

Class: F.Y.B.Sc. (Semester – I)
Course Code: USMT113
Title of the Course: Practical based on USMT111 and USMT112
Credit: 2

Course Outcomes:

CO1: Apply the principles of mathematical induction and complex numbers to solve problems in various mathematical contexts.
CO2: Demonstrate an understanding of relations and functions and their properties through practical exercises.
CO3: Utilize divisibility and congruences to analyze integers and solve modular arithmetic problems.
CO4: Perform operations on matrices, calculate determinants, rank, eigenvalues, and eigenvectors, and apply Cayley-Hamilton theorem in practical settings.
CO5: Solve systems of linear equations using appropriate methods and analyze their properties.
CO6: Grasp the foundational concepts of real numbers and apply them to analyze mathematical situations.
CO7: Effectively represent and analyze graphs and functions using both manual and software-based approaches (Maxima).
CO8: Understand the behavior of sequences, including convergence and divergence, and apply them to solve problems.
CO9: Apply the concept of series, including convergence tests, to evaluate infinite sums.

Course Objectives for FYBSc Mathematics Practical:

Algebra:
1. Verify the validity of statements using mathematical induction.
2. Solve equations and inequalities involving complex numbers.
3. Identify and classify different types of relations and functions.
4. Perform graphical and algebraic operations on functions.
5. Apply divisibility rules to factor integers and solve linear congruences.

Calculus I:
1. Perform arithmetic operations on real numbers and identify their properties.
2. Apply real number concepts to order sets, absolute values, and inequalities.
3. Plot graphs of functions by hand and using Maxima software.
4. Analyze properties of functions, including domain, range, continuity, and limits.
5. Identify convergent and divergent sequences using various tests.

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3				2			3
CO 2	3	3	2						3

CO 3	3	3			2				3
CO 4	3	3		2		2			3
CO 5	3	3	2			2			3
CO 6	3	3		2	2				3
CO 7	3	3	2		2				3
CO 8	3	3				2			3
CO 9	3	3		2		2			3

PO 1: Disciplinary Knowledge:

All COs contribute to developing a strong foundation in fundamental mathematical concepts and techniques used throughout the B.Sc program. Students gain practical experience applying these concepts in various contexts

PO2:Critical Thinking and Problem Solving:

All of these course outcomes COs require analyzing situations, formulating solutions, and applying mathematical tools to solve problems. Students learn to think critically, reason logically, and develop creative approaches to tackling complex problems.

PO 3: Communication and Team work:

COs 2, 5, and 7 involve analyzing and interpreting graphs, functions, and mathematical results. Students present their findings and collaborate on solving problems, honing their communication and teamwork skills.

PO4: Research-related skills and Scientific temper:

COs 4,6, and 9 involve exploring properties of matrices, real numbers, and series. Students learn to analyze data, draw conclusions, and develop a scientific approach to investigating mathematical concepts.

PO5:Trans-disciplinary Knowledge:

COs 3, 6 and 7 connect mathematical concepts to applications in other disciplines like physics, engineering, and computer science. Students learn to utilize mathematical tools to solve problems in diverse fields.

PO6:Personal and professional competence:

COs 1, 4, 5, 8 and 9 require independent work, applying algorithms, and analyzing results. Students develop time management skills, self-reliance, and the ability to work effectively under pressure.

PO9:Self-directed and Life-long learning:

All COs promote independent learning, exploration, and curiosity. Students learn to actively seek information, solve new problems, and adapt to new mathematical concepts, fostering lifelong learning skills.

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