

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

Autonomous

Course Structure for B.Sc. Mathematics (2019 Pattern)

F. Y. B. Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits
I	MAT1101	Algebra	2
	MAT1102	Calculus-I	2
	MAT1103	Practical Based on MAT1101 & MAT1102	2
II	MAT1201	Geometry	2
	MAT1202	Calculus-II	2
	MAT1203	Practical Based on MAT1201 & MAT1202	2

S. Y. B. Sc. Mathematics

Semester	Course Code	Title of Course	No. of Credits
III	MAT2301	Multivariable Calculus-I	3
	MAT2302	Laplace Transform & Fourier Series	3
	MAT2303	Practical Based on MAT2301 & MAT2302	2
IV	MAT2401	Linear Algebra	3
	MAT2402	Multivariable Calculus-II	3
	MAT2403	Practical Based on MAT2401 & MAT2402	2

T.Y.B.Sc Mathematics

Semester	Course Code	Title of Course	No. of Credits
V	MAT3501	Metric Spaces	3
	MAT3502	Real Analysis I	3
	MAT3503	Group Theory	3
	MAT3504	Ordinary Differential Equation	3
	MAT3505	Operation Research	3
	MAT3506	Number Theory	3
	MAT3507	Practical based on MAT3501 & MAT3502	2
	MAT3508	Practical based on MAT3503 & MAT3504	2
	MAT3509	Practical based on MAT3505 & MAT3506	2
VI	MAT3601	Complex Analysis	3
	MAT3602	Real Analysis II	3
	MAT3603	Ring Theory	3
	MAT3604	Partial Differential Equation	3
	MAT3605	Optimization Techniques	3
	MAT3606	Lebesgue Integration	3
	MAT3607	Practical based on MAT3601, MAT3602 & MAT3603	2
	MAT3608	Practical based on MAT3604, MAT3605 & MAT3606	2
	MAT3609	Project	2

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SYLLABUS (CBCS) FOR F. Y. B. Sc. MATHEMATICS
(w.e.f. June, 2019)

Academic Year 2019-2020

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

Course Code: MAT1101

Course : I

Title of Course : Algebra

Credit : 2

No. of lectures: 36

TOPICS/CONTENTS:

Unit 01: Induction [3 Lectures]

- 1.1 Well ordering principle for natural numbers
- 1.2 Principle of Mathematical induction (Strong form)

Unit 02: Sets, Relations and Functions [8 Lectures]

- 2.1 Definition of set, Operation on sets, Power set, Cartesian product of sets.
- 2.2 Definition of relation, equivalence relation, equivalence classes, partition of a set.
- 2.3 Definition of function, domain, co-domain, and the range of function, injective, surjective, bijective functions, composite functions, invertible functions.

Unit 03: Integers [6 Lectures]

- 3.1 Divisibility, Division algorithm, Euclidean algorithm, Properties of G.C.D. and L.C.M.
- 3.2 Primes, Euclid's lemma, Unique factorization theorem (Statement only).
- 3.3 Congruences: Definition and elementary properties, Fermat's little theorem (Statement only).
- 3.4 Euler's phi-function.

Unit 04: Complex Numbers [5 Lectures]

- 4.1 Addition and multiplication of complex numbers, Modulus and amplitude of complex numbers, Real and imaginary parts and conjugate of complex numbers.
- 4.2 Geometric representation of sum, difference, product and quotient of two complex numbers as well as modulus, amplitude and conjugate.
- 4.3 De'Moivre's theorem, Roots of unity, Euler's formula.

Unit 05: Matrices and system of linear equations [14 Lectures]

- 5.1 Matrices, Row echelon and reduced row echelon form of a matrix, Rank of matrix.
- 5.2 System of linear equations, Matrix form of system of linear equations, Homogeneous and non-homogeneous system of linear equations, Gauss elimination, Gauss-Jordan methods.
- 5.3 Consistency of a system of linear equations, condition of consistency (Without proof).
- 5.4 Eigen values, Eigen vectors, Characteristic equation of a matrix.
- 5.5 Cayley Hamilton theorem (Statement only), Inverse of matrix.

Textbook:

1. David M. Burton, Elementary Number Theory, Tata McGraw Hill, 7th Edition, 2012.
(Sections: 1.1 , 2.1 to 2.4, 4.2, 5.2, 7.2, 7.3)
2. H. Anton, C. Rorres, Elementary linear algebra with applications, Wiley 7th Edition, 1994 (Sections: 1.1 to 1.6, 6.1, 9.1 to 9.3)
3. Kenneth Rosen, Discrete Mathematics and its Applications, Tata McGraw Hill.
(Sections: 2.1 to 2.3, 7.1 , 7.5)

Reference Books:

1. Tom M. Apostol, Calculus Volume – I, Wiley International Edition, 2007.
 2. A Foundation Course in Mathematics , Ajit Kumar , S. Kumeareson , Bhaba Sarma
 3. Robert G. Bartle, Donald R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 4th Edition, 2011.
 4. Ruel V. Churchill, W. Brown, Complex Variables and Applications, Tata McGraw Hill, 9th Edition
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Class : F.Y. B. Sc. (Semester- I)

Course Code: MAT1102

Course : II

Title of Course : Calculus I

Credit : 2

No. of lectures: 36

TOPICS/CONTENTS:

Unit 01: Introduction to Real Numbers: [15 lectures]

- 1.1 The Set \mathbb{N} of Natural Numbers
- 1.2 The Set \mathbb{Q} of Rational Numbers
- 1.3 The Set \mathbb{R} of Real Numbers
- 1.4 The Completeness Axiom
- 1.5 The symbols $+\infty$ and $-\infty$

Unit 02: Sequences [18 lectures]

- 2.1 Limits of Sequences
- 2.2 A discussion about Proofs
- 2.3 Limit theorems for Sequences
- 2.4 Monotone Sequences and Cauchy Sequences
- 2.5 Subsequences
- 2.6 \limsup 's and \liminf 's

Unit 03: Series [3 lectures]

- 3.1 Introduction, Definition & examples , Partial Sums
- 3.2 Ratio Test (without proof)
- 3.3 Root Test (without proof)

Text Book:

Elementary Analysis (Second Edition), Kenneth A. Ross, Springer

Sections: 1 to 5, 7 to 12 &15

Reference Books:

1. A Course in Calculus and Analysis by Sudhir Ghorpade and BalmohanLimaye, Springer 2006.
 2. Principles of Mathematical Analysis , W. Rudin, Third Edition, McGraw Hill, 1976
 3. Mathematical Analysis , Tom M. Apostol.
 4. Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, Third Edition, John Wiley and Sons,2002
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Class : F.Y. B. Sc. (Semester- I)

Course Code: MAT1103

Course : III

Title of Course : Practical Based on
MAT1101 & MAT1102

Credit : 2

No. of lectures: 48

Title of Experiments:

Algebra:

1. Induction and complex numbers.
2. Relations and functions.
3. Divisibility and congruences.
4. Matrices: Determinant, rank, Eigen values and Eigen vectors, Cayley Hamilton theorem.
5. System of linear equations
6. Miscellaneous

Calculus I:

1. Real Numbers
2. Graphs and functions with & without using software Maxima
3. Sequence -I
4. Sequence-II
5. Series
6. Miscellaneous

Class: F.Y.B.Sc. (Semester – I)

Course Code: MAT 1101

Course: 1

Credit: 2

Title of the Course: Algebra

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. To comprehend the fundamental concepts of systems of linear equations, including their representation, solution methods, and applications in various fields.
8. To develop proficiency in performing operations on matrices, including finding inverses, determinants, and applying these operations to solve systems of equations efficiently.
9. To introduce the concept of eigenvalues and eigenvectors, and explore their significance in linear transformations, stability analysis, and applications in diverse areas such as engineering, physics, and data analysis.

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. Students will be able to solve complex systems of linear equations using appropriate methods, including Gaussian elimination, matrix operations, and techniques for finding inverse matrices.
7. Students will be able to analyze and interpret the properties of eigenvalues and eigenvectors in matrices, apply these concepts to solve problems in various disciplines,

and comprehend their significance in real-world scenarios such as stability analysis, principal component analysis (PCA), and differential equations.

Mapping of Program Outcomes with Course Outcomes

Class: FYBSc (Sem I)
Course: Algebra
 MAT1101

Subject: Mathematics
Course Code:

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

Course Outcomes	Programme Outcomes (POs)								
	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	2							

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: Students will acquire vital problem-solving skills by mastering diverse methods such as Gaussian elimination, matrix operations, and inverse matrix techniques, crucial for solving intricate systems of linear equations within their disciplinary knowledge.

CO7: Understanding eigenvalues and eigenvectors enables students to unravel matrix properties crucial for problem-solving across disciplines, such as stability analysis, PCA, and differential equations, offering insights into fundamental mathematical principles applied in real-world contexts.

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: Understanding diverse methods like Gaussian elimination, matrix operations, and inverse matrix techniques cultivates versatile problem-solving skills essential for tackling intricate systems of linear equations.

CO7: Understanding eigenvalues and eigenvectors enables students to decipher complex systems' stability, perform effective PCA, and solve differential equations, fostering critical thinking by applying these concepts across diverse disciplines for real-world problem-solving.

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

CO1: Students will apply set operations to analyze complex interdisciplinary problems, fostering critical thinking and problem-solving skills across diverse fields.

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

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. (Semester – I)

Course Code: MAT 1102

Course: 2

Credit: 2

Title of the Course: Calculus-I

No. of Lectures: 36

Course Outcomes:

- C01 Students will able to classify real numbers and recognize different properties that exists with real numbers.
- C02 Students will able to understand the concept of supremum and infimum and their applications.
- C03 Students will apply these concepts for advanced study in Mathematics (Real Analysis, Complex Analysis, topology).
- C04 Students will able to understand the definition of limits and convergence in the context of sequences and series of real numbers.
- C05 Students will able to compute limits of sequences involving elementary functions.
- C06 Students will able to prove statements involving convergence arguments.
- C07 Students will apply limit of sequence 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: MAT1102

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. Strategies.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 CO7contribute 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: MAT 1103

Title of the Course: Practical based on MAT1101 and MAT1102

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.

Course Outcomes	Programme Outcomes (POs)								
	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.