



Hindi Vidya Prachar Samiti's
Ramniranjan Jhunjhunwala College
of Arts, Science & Commerce
(Empowered Autonomous Status)

Affiliated to
UNIVERSITY OF MUMBAI
Syllabus for the T.Y.B.Sc. (under NEP)
Program: B.Sc. Mathematics
Program Code: RJSUMAT
Course: Discipline Specific Electives
Course Code: RJDSEMAT & RJDSEMATP

**(REVISED in 2024-2025 in alignment with the NEP 2020 facilitating the inter-and
multidisciplinary learning and multiple entry and exit of the students)**

(CBCS 2025-2026)

THE PREAMBLE

Why Mathematics?

Mathematics is the language of all Science, Engineering, and Technology. Mathematics is considered the queen of sciences. Without Mathematics, there can be neither science nor engineering. Mathematics occupies a crucial and unique role in human societies and represents a strategic key in the development of the whole of mankind. Mathematics is around us. It is present in different forms; the list is just endless if one goes on to note down the situations when our computational skill or more specifically, simple mathematics comes to play a role, almost every next moment we do the simple calculations at the back of our mind. Of course, these are all done pretty unconsciously without a thought being spared for the use of mathematics on all such occasions. Mathematics helps the man to give exact interpretation to his ideas and conclusions. It is the numerical and calculation part of man's life and knowledge. It plays a predominant role in our everyday life and it has become an indispensable factor for the progress of our present-day world. Further, in modern times, the adoption of mathematical methods in the social, medical and physical sciences has expanded rapidly, confirming mathematics as an indispensable part of undergraduate curricula and creating a great demand for mathematical training. Much of the demand stems directly from the need for mathematical modeling of phenomena. Such modeling is basic to all engineering, plays a vital role in all physical sciences and contributes significantly to the biological sciences, medicine, psychology, economics and commerce. The numerous applications of the subject in almost every field makes mathematics the most versatile subject choice.

Why Mathematics at R J College?

The department of Mathematics of R J College is the department as old as the college itself. It started in 1963, the inception year of the college and since then has remained as the center of academic activities for the subject. With a legacy of more than 6 decades, today the department offers undergraduate programs in the subject of mathematics with more than one discipline-specific elective paper and is affiliated to, and recognized by the University of Mumbai. As an applied component in the final year, mathematics students learn computer programming languages like Java, SQL, and python along with system analysis. Series of guest lectures, Problem-solving sessions, lecture-based learning, bridge courses, institute visits etc. motivate students to explore more in terms of applications of the subject. Under autonomy, the department has made the curriculum more robust by incorporating skill-based learning and value-added course that imparts practical knowledge of the subject to the students. Every year the department organizes a seminar competition on the theme 'Applications of Mathematics' in various areas. Department of Mathematics also runs a value-added course in a year and is able to attract students from other disciplines of science enrolling for these courses. Department of mathematics has received funding from the Department of Biotechnology (DBT), New Delhi to further strengthen our hands in being

able to provide hands-on training to the students to satisfy their curiosity and inculcate research aptitude.

Our Curriculum, Your Strength

The syllabus for mathematics for the total six semesters is meticulously designed so as to make students understand the diversity of subject. From learning elementary calculus and basic algebra, students move on to applied aspects of the subject in terms of Real analysis, multivariable calculus, Complex analysis, abstract algebra. Specialized training in differential equations, numerical methods is a part of the learning process. The teaching staffs of the department of mathematics are highly qualified and are dedicated to their subjects giving a friendly environment for the students. The department always aims to develop skills, ideas and overall progress of the students. Many of our students participate and get awards in various activities like MTTS program, Madhava Mathematics competition and other competitive exams. The environment of the department is very friendly which is useful for the students coming from other colleges also.

CREDIT STRUCTURE FOR SEMESTER V

Course	Nomenclature	Credits	Topics
DISCIPLINE SPECIFIC ELECTIVES (ANY ONE from A and B)			
RJDSEMAT35A	Difference Equations	04 (03L+01P)	1. Calculus of finite differences 2. Linear difference equations 3. Systems of difference equations
RJDSEMAT35B	Number Theory & Applications-I	04 (03L+01P)	1. Congruences and Factorization 2. Diophantine Equations and their Solutions 3. Primitive Roots and Cryptography

CREDIT STRUCTURE FOR SEMESTER VI

Course	Nomenclature	Credits	Topics
DISCIPLINE SPECIFIC ELECTIVES (ANY ONE from A and B)			
RJDSEMAT36A	Transform Methods	04 (03L+01P)	1. Laplace transform 2. Inverse Laplace transform 3. Z-transform
RJDSEMAT36B	Number Theory & Applications-II	04 (03L+01P)	1. Quadratic Reciprocity 2. Continued Fractions 3. Arithmetic Functions and Special Numbers

T.Y.B.Sc. Semester V Mathematics (Major) Syllabus

Discipline Specific Electives: Elective A

Title: Difference Equations

Course code: RJDSEMAT35A

Credits: 04 (03L+01P)

UNIT 1: Calculus of Finite Differences

[15 hours]

The first, second and higher differences of function, the difference operators, the operator E , properties of Δ , ∇ , and E , equivalence of operators, summation, indefinite summation, the fundamental theorem of difference calculus, generating functions, Bernoulli's polynomials and numbers.

UNIT 2: Linear Difference Equations

[15 hours]

Basic definitions, existence and uniqueness theorem, first-order linear difference equations, general results for linear difference equations, method of variation of parameters, solving linear difference equations, linear difference equations with constant coefficients.

UNIT 3: Systems of Difference Equations

[15 hours]

Initial value problems for linear systems, homogeneous systems, the Putzer algorithm, solving of linear systems, time-varying linear systems, fundamental matrices and properties, Non-homogeneous systems.

Discipline Specific Elective A: Practical

Course code: RJDSEMATP35A

List of practicals based on Difference Equations

[30 hours]

1. Problems based on difference operators and their equivalence
2. Problems based on summation, generating functions and Bernoulli polynomials and Bernoulli numbers
3. Problems based on method of variation of parameters
4. Problems based on linear differential equations with constant coefficients
5. Problems based on initial value problems for linear systems
6. Problems based on linear and nonlinear systems

Recommended books:

1. Walter G. Kelley and Allan C. Peterson, Difference Equations, An Introduction with Applications, second edition, Academic Press, Inc., 2001.
2. Youssef N. Raffoul, Difference Equations and Applications, Academic Press, Inc., 2025.

Reference books:

1. Paul Cull, Mary Flahive, and Robby Robson. Difference Equations: From Rabbits to Chaos, Springer, 2005.
2. Saber Elaydi, An Introduction to Difference Equations, third edition, Springer, New York, 2005.
3. Samuel Goldberg, Introduction to Difference Equations. Dover publications, Inc., New York, 1986.
4. V. Lakshmikantham and D. Trigiante. Theory of Difference Equations, Academic Press, Inc., 1988.
5. H. Levy and F. Lessman. Finite Difference Equations, Dover Publications, Inc., New York, 1992.
6. Ronald E. Mickens. Difference Equations Theory, Applications, and Advanced topics, third edition, CRC Press, 2015.

SEMESTER	V DISCIPLINE SPECIFIC ELECTIVES
TITLE OF THE COURSE	DIFFERENCE EQUATIONS
COURSE CODE	RJDSEMAT35A & RJDSEMATP35A
CREDITS	04 (03L+01P)
DURATION	75 (45+30) HOURS

LEARNING OBJECTIVES

1	To become conversant with the domain knowledge and concepts of difference calculus and difference equations
2	To develop sophisticated skill to solve difference equations and analyze properties of solution.
3	To understand the solutions of discrete models

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO addressed	BLOOM'S LEVEL
CO1	understand difference operators and their relations	1,4,6	2,3
CO2	solve difference equations by elementary mathematical methods	1,3,6	2,3
CO3	model discrete phenomena using difference equations	1,3,4,6	2,3

Discipline Specific Electives: Elective B

Title: Number Theory & Applications-I

Course code: RJDSEMAT35B

Credits: 04 (03L+01P)

UNIT 1: Congruences and Factorization

[15 hours]

Review of Divisibility, Primes and the fundamental theorem of Arithmetic.

Congruences, Complete residue system modulo m , Reduced residue system modulo m , Fermat's little Theorem, Euler's generalization of Fermat's little Theorem, Wilson's theorem, Linear congruences, Simultaneous linear congruences in two variables. The Chinese remainder Theorem, Congruences of Higher degree, The Fermat-Kraitchik Factorization Method.

UNIT 2: Diophantine Equations and their Solutions

[15 hours]

The linear Diophantine equation $ax + by = c$. The equation $x^2 + y^2 = z^2$, Primitive Pythagorean triple and its characterisation, The equations $x^4 + y^4 = z^2$ and $x^4 + y^4 = z^4$ have no solutions $(x; y; z)$ with $xyz \neq 0$. Fermat's two squares theorem, sum of three squares, Lagrange's four squares theorem.

UNIT 3: Primitive Roots and Cryptography

[15 hours]

Order of an integer and Primitive Roots. Basic notions such as encryption (enciphering) and decryption (deciphering), Cryptosystems, symmetric key cryptography, Simple examples such as shift cipher, Affine cipher, Hill's cipher, Vigenere cipher, digraph transformations. Concept of Public Key Cryptosystem; RSA Algorithm, Digital Signatures, ElGamal Cryptosystem.

Discipline Specific Elective B: Practical

Course code: RJDSEMATP35B

List of Practicals based on Number Theory & Applications-I

[30 hours]

1. Fermat's theorem, Wilson's theorem, Euler's theorem
2. Chinese remainder theorem, linear and higher order congruences, factorization
3. Linear Diophantine equations

4. Pythagorean triples, sum of squares
5. Primitive roots
6. Cryptography

Recommended Books:

1. David M. Burton, An Introduction to the Theory of Numbers, Tata McGraw Hill Edition.
2. T. Koshy, Elementary number theory with applications, 2nd edition, Academic Press.

Reference Books

1. Niven, H. Zuckerman and H. Montgomery, An Introduction to the Theory of Numbers, John Wiley & Sons. Inc.
2. G. H. Hardy and E.M. Wright. An Introduction to the Theory of Numbers. Low priced edition. The English Language Book Society and Oxford University Press.
3. Neville Robins, Beginning Number Theory, Narosa Publications.
4. S.D. Adhikari, An introduction to Commutative Algebra and Number Theory, Narosa Publishing House.
5. N. Koblitz, A course in Number theory and Cryptography, Springer.
6. M. Artin, Algebra, Prentice Hall.
7. K. Ireland, M. Rosen, A classical introduction to Modern Number Theory, Second edition, Springer Verlag.
8. William Stallings, Cryptology and network security, Pearson Education.
9. A. Baker, A comprehensive course in number theory, Cambridge.

SEMESTER	V DISCIPLINE SPECIFIC ELECTIVES
TITLE OF THE COURSE	NUMBER THEORY & APPLICATIONS-I
COURSE CODE	RJDSEMAT35B & RJDSEMATP35B
CREDITS	04 (03L+01P)
DURATION	75 (45+30) HOURS

LEARNING OBJECTIVES	
1	To be able to implement elementary methods of cryptography.
2	Should be able to handle higher power in integers.
3	Understanding of classical problems in number theory.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO addressed	BLOOM'S LEVEL
CO1	understand applications of Fermat's theorem, Euler's theorem, Wilson's theorem	1,3,6	2,3
CO2	learn use of primes and congruences in the field of Cryptography	1,3,6	2,3
CO3	learn solvability of Pythagorean triples and linear nonlinear Diophantine equations	1,3,6	2,3

T.Y.B.Sc. Semester VI Mathematics (Major) Syllabus

Discipline Specific Electives: Elective A

Title: Transform Methods

Course code: RJDSEMAT36A

Credits: 04 (03L+01P)

UNIT 1: Laplace Transform

[15 hours]

Definition, existence theorem, Laplace transform of some elementary functions, Basic operational properties of Laplace transform, Laplace transform of derivatives, Laplace transform of integrals, methods of finding Laplace transform, Laplace transform of some special functions, initial value theorem, final value theorem.

UNIT 2: Inverse Laplace Transform

[15 hours]

Definition, inverse Laplace transform, Lerche's theorem, inverse Laplace transform of some elementary functions, Basic operational properties of inverse Laplace transform, inverse Laplace transform of derivatives, inverse Laplace transform of integrals, series method, convolution theorem, complex inversion formula, simple applications involving Laplace transform: evaluating integrals, solving ODE and PDE.

UNIT 3: Z-Transform

[15 hours]

Definition, (unilateral and bilateral), Z-transform of some standard functions, properties of Z-transforms, initial value theorem, final value theorem, inverse Z-transform, partial fraction method, power series method, convolution theorem, simple applications to difference equations.

Discipline Specific Elective A: Practical

Course code: RJDSEMATP36A

List of practicals based on Transform Methods

[30 hours]

1. Problems based on Laplace transforms of elementary functions
2. Problems based on Laplace transforms of elementary functions
3. Problems based on inverse Laplace transforms, evaluating integrals, solving ODE
4. Problems based on convolution theorem, evaluating integrals, and solving ODE
5. Problems based on z-transform of some standard functions
6. Problems based on inverse z-transform, simple applications involving z-transform

Recommended books:

1. Larry C. Andrews and Bhimsen K. Shivamoggi, Integral Transforms for Engineers, Prentice-Hall of India, New Delhi, 2005.
2. Baidyanath Patra, An Introduction to Integral Transforms, CRC Press, Taylor and Francis Group, Boca Raton, 2018.

Reference books:

1. Brain Davies, Integral Transforms and their Applications, third edition, Springer--Verlag, New York, 2002.
2. Lokenath Debnath and Damaru Bhata, Integral Transforms and their Applications, Campman & Hall/CRC, Taylor & Francis Group, 2007.
3. Saber Elaydi, An Introduction to Difference Equations, third edition, Springer, New York, 2005.
4. E. I. Jury, Theory and Applications of the Z-transform Method, Robert E. Krieger Publishing C. Huntington, New York, 1964.

SEMESTER	VI DISCIPLINE SPECIFIC ELECTIVES
TITLE OF THE COURSE	TRANSFORM METHODS
COURSE CODE	RJDSEMAT36A & RJDSEMATP36A
CREDITS	04 (03L+01P)
DURATION	75 (45+30) HOURS

LEARNING OBJECTIVES

1	Laplace transform and its basic operational properties
2	Evaluation of integrals and solving ode by Laplace transform
3	z-transform and simple applications to difference equations

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO addressed	BLOOM'S LEVEL
CO1	Apply theory and applications of Laplace and inverse Laplace transforms	1,4,6	2,3
CO2	Solving ODE using transform techniques	1,3,4,6	2,3
CO3	Learn theory and applications of z-transform and inverse z-transform	1,3,4,6	2,3

Discipline Specific Electives: Elective B

Title: Number Theory & Applications-II

Course code: RJDSEMAT36B

Credits: 04 (03L+01P)

UNIT 1: Quadratic Reciprocity

[15 hours]

Quadratic residues and Legendre Symbol, Gauss' Lemma, Theorem on Legendre Symbols $(-1/p)$ and $(2/p)$, Quadratic Reciprocity law and its applications, The Jacobi Symbol and law of reciprocity for Jacobi Symbol. Quadratic Congruences with Composite moduli.

UNIT 2: Continued Fractions

[15 hours]

Finite continued fractions. Infinite continued fractions and representation of an irrational number by an infinite simple continued fraction, Rational approximations to irrational numbers and order of convergence, Best possible approximations. Periodic continued fractions. Pell's equations and their solutions.

UNIT 3: Arithmetic function and Special numbers

[15 hours]

Arithmetic functions of number theory: $\tau(n)$, $\sigma(n)$, $\omega(n)$, $\phi(n)$ and their properties, $\mu(n)$ and the Mobius inversion formula.

Special numbers: Fermat numbers, Mersenne numbers, Perfect numbers, Amicable numbers, Pseudoprimes, Carmichael numbers.

Discipline Specific Elective B: Practical

Course code: RJDSEMATP36B

List of Practicals based on Number Theory & Applications-II

[30 hours]

1. Legendre Symbol, Gauss' Lemma, quadratic reciprocity law
2. Jacobi Symbol, quadratic congruences with prime and composite moduli
3. Finite and infinite continued fractions
4. Approximations and Pell's equations
5. Arithmetic functions of number theory

6. Special numbers

Recommended Books:

1. David M. Burton, An Introduction to the Theory of Numbers, Tata McGraw Hill Edition.
2. T. Koshy, Elementary number theory with applications, 2nd edition, Academic Press.

Reference Books

1. Niven, H. Zuckerman and H. Montgomery, An Introduction to the Theory of Numbers, John Wiley & Sons. Inc.
2. G. H. Hardy and E.M. Wright, An Introduction to the Theory of Numbers, Low priced edition, The English Language Book Society and Oxford University Press.
3. Neville Robins, Beginning Number Theory, Narosa Publications.
4. S.D. Adhikari, An introduction to Commutative Algebra and Number Theory, Narosa Publishing House.
5. N. Koblitz. A course in Number theory and Cryptography, Springer.
6. M. Artin, Algebra, Prentice Hall.
7. K. Ireland, M. Rosen. A classical introduction to Modern Number Theory. Second edition, Springer Verlag.
8. William Stallings, Cryptology and network security, Pearson Education.
9. A. Baker, A comprehensive course in number theory, Cambridge.

SEMESTER	VI DISCIPLINE SPECIFIC ELECTIVES
TITLE OF THE COURSE	NUMBER THEORY & APPLICATIONS-II
COURSE CODE	RJDSEMAT36B & RJDSEMATP36B
CREDITS	04 (03L+01P)
DURATION	75 (45+30) HOURS

LEARNING OBJECTIVES

1	To understand that better approximations of irrational numbers can be done through continued fractions.
2	To know Pell's equation and role of continued fractions in its solution.
3	To be able to solve quadratic congruences through the help of quadratic reciprocity law.

COURSE OUTCOME NUMBER	On completing the course, the student will be able to:	PSO addressed	BLOOM'S LEVEL
CO1	understand use concepts and uses of finite continued fractions	1,3	2,3
CO2	learn relation between irrational numbers and infinite continued fractions	1,3	2,3
CO3	learn special numbers such as Fermat numbers, Amicable numbers, perfect numbers and Mersenne numbers.	1,3	2,3

Suggestive Scheme of Examination

Internal Assessments: There will be one Internal Assessment of 30 marks for each of the DSE courses RJDSEMAT35A or RJDSEMAT35B of Semester V and RJDSEMAT36A or RJDSEMAT36B of Semester VI.

Internal Assessment Pattern: There will be one internal examinations for DSE course RJDSEMAT35A or RJDSEMAT35B of Semester V and RJDSEMAT36A or RJDSEMAT36B of Semester VI. The internal assessment will be based on class tests / projects / assignments / book review / /open book tests/ seminars.

Semester End Theory Examinations: There will be a Semester end theory examination of 45 marks for DSE course RJDSEMAT35A or RJDSEMAT35B of Semester V and RJDSEMAT36A or RJDSEMAT36B of Semester VI.

1. Duration: The examinations shall be of 1.5 Hour duration.

2. Theory Question Paper Pattern:

Question Number	Unit	Particulars	Answer	Marks
1	1	A) Theory B) Theory	Attempt any one	7
		a) Problem b) Problem c) Problem d) Problem	Attempt any two	4 x 2=8
2	2	A) Theory B) Theory	Attempt any one	7
		a) Problem b) Problem c) Problem d) Problem	Attempt any two	4 x 2=8
3	3	A) Theory B) Theory	Attempt any one	7
		a) Problem b) Problem c) Problem d) Problem	Attempt any two	4 x 2=8

Semester End Practical Examinations:

At the end of the Semesters V and VI Practical examinations of 30-minute duration and of 25 marks shall be conducted for the DSE course RJDSEMAT35A or RJDSEMAT35B of Semester V and RJDSEMAT36A or RJDSEMAT36B of Semester VI.

Paper pattern: The question paper will be of 20 marks and shall have two Sections.

Section A Objective Questions: Attempt any Four out of Six multiple choice questions.

(4 x 2 = 08 Marks)

Section B Descriptive Problems: Three questions based on each unit with internal choices.

(4x 3 = 12 Marks)

Marks for Journals:

For each DSE course RJDSEMAT35A or RJDSEMAT35B of Semester V and RJDSEMAT36A or RJDSEMAT36B of Semester VI.

Journals: 05 marks.

Each Practical of every DSE course of Semester V and VI shall contain 10 (ten) problems out of which minimum 05 (five) have to be written in the journal. A student must have a certified journal before appearing for the practical examination.