

# GANITA MANJARI

Textbook of Mathematics for



DB04

विद्यया ऽ मृतमश्नुते



एन सी ई आर टी  
NCERT

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्  
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

0904 – GANITA MANJARI  
Textbook of Mathematics for Grade 9 (Part I)

ISBN 978-93-5729-603-8

**First Edition**

April 2026 Chaitra 1948

PD 2000T BS

© National Council of Educational  
Research and Training, 2026

₹ 115.00

Printed on 80 GSM paper with NCERT  
watermark

Published at the Publication  
Division by the Secretary, National  
Council of Educational Research  
and Training, Sri Aurobindo Marg,  
New Delhi 110016 and printed at  
Krown Printers, B-20/1 (GF, FF,  
SF, Fourth Floor), Okhla Indl. Area,  
Phase-2, New Delhi-110020

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## FOREWORD

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The National Education Policy (NEP) 2020 envisions an education system that is firmly rooted in India's cultural and intellectual wisdom, values, and ethical traditions. The rich intellectual heritage simultaneously enables learners to engage meaningfully with the complexities and possibilities of a rapidly changing world. The National Curriculum Framework for School Education (NCF-SE) 2023 provides concrete expression to this vision by laying out a coherent curricular pathway across various stages of schooling that nurtures critical thinking, creativity and sensitivity, along with the values and dispositions that are needed for responsible citizenship in an interconnected global society.

Learners have progressed through the Foundational, Preparatory and Middle Stages, where their inherent potential has been nurtured holistically. Now, they enter the Secondary Stage with enhanced capacity for reflection, reasoning, enquiry, and self-expression. Spanning across Grades 9 to 12. It marks a crucial period in the intellectual and personal growth of the students. It prepares them to engage with abstract ideas, complex social realities, ethical dilemmas and the expanding universe of knowledge, while deepening their understanding of the self and the world around them.

The NCF-SE 2023 recommends that the curriculum for Grades 9–10 equips students with the skills that are needed to grow as they advance in their lives. Students can use these skills for reasoning, argumentation, and effective communication. It endeavours to enhance their analytical and descriptive capabilities to prepare them for the challenges and opportunities that await them. A diverse curriculum, covering ten subjects: three languages — including at least two languages native to India — Science, Mathematics, Social Sciences, Arts Education, Physical Education and Well-being, Individuals in Society/ Environmental Education, Skill Education, and AI and Computational Thinking, promotes their holistic development.

As per NCF-SE 2023, the Secondary Stage focuses on further developing students' ability to justify claims and arguments through logical reasoning. At this stage, students are expected to be comfortable working with abstractions and core techniques of Mathematics and Computational Thinking, such as mathematical modelling and algorithm development for problem-solving. They also need to strengthen key mathematical skills, including problem-solving, visualisation, optimisation, representation, and communication, thereby building essential capacities in Mathematics and Computational Thinking. Engagement with puzzles, word problems, and optimisation tasks helps nurture values and dispositions, such as perseverance, curiosity, confidence, rigour and honesty.

The Grade 9 Mathematics textbook, *Ganita Manjari* (Part I), carries forward the vision of NEP 2020 and NCF-SE 2023 by promoting mathematical thinking, problem-solving skills, and intuition among students. Mathematical thinking involves systematic and logical approaches to interpreting the world. This

textbook aims to develop students' ability in formulating well-defined problems that can be addressed through mathematical reasoning — an essential aspect of learning Mathematics. It also fosters mathematical intuition, enabling students to develop a sense of what is likely to be true in Mathematics, which is a key goal of school education.

This textbook marks an important transition from the Middle to the Secondary Stage of Mathematics. While building on students' prior experiences, it introduces greater conceptual depth, formal reasoning, and the foundations of proof. Through real-life examples and collaborative learning experiences, it enhances creativity, logical reasoning, and decision-making skills. This textbook also highlights the rich history of Mathematics in India, spanning thousands of years. By learning about mathematical developments in India and across the world, students can develop a deeper sense of cultural rootedness. The content attempts to integrate mathematics with other subject areas such as science, social science and with cross-cutting themes like environmental education, value education and inclusive education. Additionally, the inclusion of QR codes integrates technology, providing access to a variety of learning resources.

The National Council of Educational Research and Training acknowledges the contributions of the Textbook Development Team, subject experts, pedagogues, practising teachers, reviewers, and all others who have supported the development of this textbook. We hope *Ganita Manjari* inspires learners to think critically, communicate with confidence, and engage thoughtfully in society and the global community. We also warmly welcome suggestions and feedback from all its users for further improvement in the subsequent editions.

New Delhi  
April, 2026

DINESH PRASAD SAKLANI  
*Director*  
National Council of Educational  
Research and Training

## ABOUT THE BOOK

---

Mathematics at the Secondary Stage plays a crucial role in deepening students' understanding of structure, pattern, and reasoning, while also strengthening their ability to communicate ideas clearly and precisely. At this stage, mathematics moves beyond familiarity with ideas to a more systematic engagement with concepts, representations and arguments. It supports the development of logical thinking, problem-solving, and the capacity to reason with increasing abstraction, skills that are essential not only for further study in mathematics and science, but also for informed participation in society.

The Grade 9 Mathematics textbook, *Ganita Manjari*, marks an important transition from the Middle Stage to the Secondary mathematics. While remaining connected to students' prior experiences, the textbook introduces greater conceptual depth, formal reasoning, and the beginnings of proof. The chapters are carefully structured to support this transition through sequential concept building, allowing students to progress from intuitive understanding to more formal ideas in a coherent and meaningful manner. The Low Threshold–High Ceiling (LTHC) approach has been adopted to ensure accessibility for all learners while providing opportunities for deeper exploration.

Each chapter begins with an engaging introduction, often rooted in exploration or real-life contexts, to motivate the ideas that follow. Concepts are developed using multiple representations—pictorial, numerical, algebraic and graphical, so that students learn to move flexibly between different ways of thinking about mathematical ideas. Visualisation plays a central role in making abstract concepts accessible, particularly in areas, such as number systems, algebra, sequences, and mensuration.

This textbook places strong emphasis on meaningful problem solving through a rich variety of worked examples, practice problems, application-based exercises and problems requiring higher order thinking skills. Selected questions are designed to challenge students to explain their reasoning, construct arguments, and gradually engage with ideas of justification and proof. Games, puzzles and exploratory tasks are incorporated to foster computational thinking, logical reasoning, and curiosity. Some problems in each chapter are marked with an asterisk (\*). These problems require higher order thinking and deeper reasoning, and are meant for those students who wish to explore the topic in greater depth. Further, some chapters include sections marked with (\*), designed to engage motivated students in extended inquiry and project-based work. These, in the form of enrichment materials including technology-enabled explorations, open-ended tasks and additional readings, are provided to encourage independent inquiry and deeper engagement with ideas.

Questions and sections marked with (\*) are intended for enrichment, and are not to be assessed or included in examinations.

Historical references and contextual connections are included wherever appropriate to help students appreciate mathematics as a human endeavour that has evolved over ages and across cultures.

The textbook consists of 8 chapters. It is designed to strengthen conceptual understanding, while introducing students to more formal mathematical reasoning in algebra and geometry. Beginning with coordinate geometry and number systems, the book develops algebraic thinking through polynomials, sequences and progressions with an emphasis on patterns, multiple representations, and real-life contexts. Geometry is treated both historically and deductively through the chapter on circles, thereby fostering logical argumentation and proof. The mensuration chapter addresses two-dimensional figures, integrating measurement, derivation of formulas, and visualisation. Probability is introduced as a way of quantifying uncertainty, helping students understand and analyse chance events through simple experiments, logical reasoning, and real-life situations.

In alignment with the National Curriculum Framework for School Education (NCFSE), the textbook emphasises competency-based learning, conceptual coherence, and mathematical reasoning over rote procedures, promotes connections across mathematical domains and with real-life contexts, and supports diverse learning pathways through activities, explorations, and opportunities for discussion. Collectively, the chapters aim to build coherence across topics, promote representational fluency, and support a smooth transition from intuitive reasoning to formal mathematical thinking at the secondary level. Data in various forms may appear across chapters. However, it is included solely for illustrative purposes.

Chapter 1, 'Orienting Yourself: The Use of Coordinates' introduces students to the Cartesian plane, enabling them to locate points, compute distances and midpoints, and explore geometric relationships algebraically. Chapter 2, 'Introduction to Linear Polynomials' develops an understanding of algebraic expressions and linear polynomials, emphasising patterns, linear relationships, and graphical representations. Chapter 3, 'The World of Numbers' extends students' understanding from integers to rational and irrational numbers, focusing on number line representations, density of rational numbers, proofs of irrationality, and visual constructions, such as the square root spiral. Chapter 4, 'Exploring Algebraic Identities' deepens algebraic understanding through visual and geometric interpretations of identities, factorisation and simplification of expressions. Chapter 5, 'I'm Up and Down, and Round and Round' investigates properties of circles, chords, arcs, angles and cyclic figures, connecting geometric theory with real-world applications and cultural contexts. Chapter 6, 'Measuring Space: Perimeter and Area' develops measurement concepts through the study of plane figures

and circles, integrating historical methods, derivations of formulas, and ideas of generalisation. Chapter 7, 'The Mathematics of Maybe: Introduction to Probability' introduces randomness, empirical and theoretical probability, and representations, such as tables and tree diagrams, encouraging experimental and simulation-based thinking. Chapter 8, 'Predicting What Comes Next: Exploring Sequences and Progressions' explores patterns through sequences, arithmetic and geometric progressions, and recursive rules, linking algebraic ideas to visual models and fractals.

This textbook is designed to support diverse learners in the classroom, and to encourage discussion, collaboration and reflection. By emphasising connectedness across chapters and revisiting ideas in a spiralling manner, it aims to help students see mathematics as a coherent and unified discipline. Above all, the book seeks to nurture confidence, curiosity, and a growing appreciation of the power and beauty of mathematics, laying a strong foundation for further learning at the senior secondary level.

About the Title: *Ganita Manjari* brings together two ideas: *Ganita*, the timeless word for mathematics, and *Manjari* which, in various Indian languages, means a bouquet of flowers. Like a carefully gathered bunch of blossoms, this Grade 9 textbook presents mathematics as a collection of ideas — each topic a distinct petal, rich with its own colour, shape, and fragrance. The title reflects the vibrant colors and creative aspects of mathematics, and its deep connections with beauty and nature. Through patterns, reasoning, and discovery, students will see how mathematics blooms all around us — in art, in the natural world, and in everyday life. We hope that *Ganita Manjari* will entice students to explore the beautiful bouquet of ideas that make up Grades 9 and 10 mathematics.

# THE CONSTITUTION OF INDIA

## PREAMBLE

**WE, THE PEOPLE OF INDIA**, having solemnly resolved to constitute India into a <sup>1</sup>**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

**JUSTICE**, social, economic and political;

**LIBERTY** of thought, expression, belief, faith and worship;

**EQUALITY** of status and of opportunity; and to promote among them all

**FRATERNITY** assuring the dignity of the individual and the <sup>2</sup>[unity and integrity of the Nation];

**IN OUR CONSTITUENT ASSEMBLY** this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)

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# CONSTITUTION OF INDIA

## Part III (Articles 12 – 35)

(Subject to certain conditions, some exceptions and reasonable restrictions)

guarantees these

## Fundamental Rights

### Right to Equality

- before law and equal protection of laws;
- irrespective of religion, race, caste, sex or place of birth;
- of opportunity in public employment;
- by abolition of untouchability and titles.

### Right to Freedom

- of expression, assembly, association, movement, residence and profession;
- of certain protections in respect of conviction for offences;
- of protection of life and personal liberty;
- of free and compulsory education for children between the age of six and fourteen years;
- of protection against arrest and detention in certain cases.

### Right against Exploitation

- for prohibition of traffic in human beings and forced labour;
- for prohibition of employment of children in hazardous jobs.

### Right to Freedom of Religion

- freedom of conscience and free profession, practice and propagation of religion;
- freedom to manage religious affairs;
- freedom as to payment of taxes for promotion of any particular religion;
- freedom as to attendance at religious instruction or religious worship in certain educational institutions.

### Cultural and Educational Rights

- for protection of interests of minorities;
- for minorities to establish and administer educational institutions;
- saving of certain Laws 31A–31D.

### Right to Constitutional Remedies

- by issuance of directions or orders or writs by the Supreme Court and High Courts for enforcement of these Fundamental Rights.



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## ACKNOWLEDGEMENTS

The National Council of Educational Research and Training (NCERT) acknowledges the guidance and support of the esteemed Chairperson, and members of the Curricular Area Group (CAG): Mathematics, and other concerned CAGs for their guidelines on cross-cutting themes in developing this textbook. During the development of this textbook, various workshops were organised and subject experts from different Institutions were invited. The NCERT acknowledges the valuable views and inputs given by subject experts — Bina Prakash, *Senior PGT Mathematics*, Champion School, Bhopal; Gitanjali Sharma, *TGT Mathematics*, K. V. Janakpuri, New Delhi; Tanuja Negi, *TGT Mathematics*, K. V. Tughlakabad, New Delhi; Sai Venkatesh, *Teacher*, The British School, New Delhi; Chhavi Gupta, *TGT Mathematics*, GGSSS, School Block, Shakarpur, New Delhi; Deepika, *TGT Mathematics*, S. V. FU Pitampura, New Delhi; Alok Anand, *TGT Mathematics*, PM SHRI KV NMR JNU, New Delhi; Baidyanath Jha, *TGT*, Sainik School Kunjpura, Karnal, Haryana; Manoj Kumar Jha, *PGT Mathematics*, JNV, South Andaman; Umesh Rao, *TGT Mathematics*, JNV Mothuka, Faridabad; Sangeeta Yadav, *PGT and Academic Head*, St. Joseph's Convent Sr. Secondary School, Bhopal; Deeksha Malhotra, Senior Years Mathematics Educator, Shiv Nadar School, Gurgaon; Rahul Sofat, *HOD*, Mathematics, Air Force Golden Jubilee Institute, New Delhi; Rishikesh Kumar, *Assistant Professor*, DESM, NCERT, New Delhi; Shriram Chauthaiwale, *Lecturer (Retd.)*, Amolakchand College, Yavatmal.

The Council would like to express deep gratitude to R. Ramanujam, *Professor*, Azim Premji University, for his critical comments and suggestions received at several points during the development of this textbook.

We gratefully acknowledge the valuable inputs by Aditya Karnataki, *Assistant Professor*, CMI, Chennai; Prasad Jayanti, *Professor*, Dartmouth College, USA; and Saurabh Kapoor, *Assistant Professor*, RIE, Bhubaneswar, in the syllabus development process.

The Council appreciates the contributions of Nazrana Khan and Dimple, *Senior Research Associates*; Chetna Singh, *Junior Project Fellow*, Department of Education in Science and Mathematics, NCERT, for providing support in the development of the textbook.

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Acknowledgements are due for the academic and administrative support of Sunita Farkya, *Professor and Head*, DESM, NCERT, New Delhi.

The NCERT gratefully acknowledges the contributions of Kishore Singhal, Ayaz Ahmad Ansari and Geeta, *DTP Operators* (contractual), Publication Division; and Abhilash Kumar, *DTP Operator*, DESM, NCERT.

The Council acknowledges the efforts of Ilma Nasir, *Editor* (contractual) for editing this textbook. Thanks are also extended to Aastha Sharma, *Editorial Assistant* (contractual); Adiba Tasneem, Ariba Usman, Jatinder Kumar and Praveen Kumar, *Proof Readers* (contractual), Publication Division, NCERT. The Council also appreciates the efforts of Pawan Kumar Barriar, *In charge*, DTP Cell; Bittu Kumar Mahato, Shiv Shankar Dubey, Vipin Kumar Sharma, Upasana and Vivek Rajpoot, *DTP Operators* (contractual), Publication Division, NCERT, for finalising this textbook.

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## NOTE TO THE TEACHER

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The Grade 9 Mathematics textbook, *Ganita Manjari*, is intended to support you in the important task of guiding students as they transition from middle school to secondary school mathematics, a stage where ideas become more abstract and reasoning, justification, and connections across concepts assume greater significance. At this level, mathematics learning must move beyond following procedures to making sense of underlying structures, relationships, and representations.

Classrooms that encourage students to actively engage with ideas by exploring patterns, making conjectures, testing examples, justifying claims and discussing alternative approaches, all of which are essential for developing mathematical thinking. Students should be given regular opportunities to reason, argue and communicate their ideas, both orally and in writing. Such practices reflect how mathematics itself develops and help students see mathematics as a meaningful and connected discipline rather than a collection of rules.

Creating this environment does not require elaborate arrangements. Posing a carefully chosen question, encouraging multiple paths of inquiry and solution strategies, while allowing adequate time for discussion and reflection can significantly enrich classroom learning. Equally important is nurturing a classroom culture where errors are treated as opportunities for learning and refinement of ideas. ‘Think and Reflect’ is a special feature which has been added to this book. As you navigate the content of the chapters, these questions will enable you to engage students in the class, to delve deeper into a new concept and to facilitate whole-class discussion.

As mathematical justification and proof begin to assume a more prominent role at this stage, students should be gently guided towards explaining why results hold, without undue pressure for formalism. Encouraging experimentation, use of examples and counterexamples, and intuitive reasoning can support this progression towards more formal arguments.

The textbook includes a variety of problems designed to promote exploration, reasoning, and consolidation of concepts. Attempting to ‘cover’ all problems mechanically should be avoided if it compromises opportunities for deep engagement. Problems appear in the chapters in the form of practice exercises as well as end-of-chapter exercises. The practice exercises appear after each section and will enable the student to understand and apply the concept as well as acquire the procedural fluency needed. The end-of-chapter exercises include problems drawn from concepts across the chapter, and are intended to help students consolidate the concepts and skills developed. In addition, some questions are marked with an asterisk (\*). These problems require higher-order thinking and deeper reasoning, and it is recommended that some classroom time be devoted to discussing and solving them, even though they are not meant for assessment and will not be asked in examinations.

An emphasis is also placed on developing students as independent learners. Reading mathematical text, interpreting definitions, and making sense of

worked examples are important skills at this level. Encouraging students to read the textbook independently and discuss their interpretations can help them gain confidence in engaging with mathematical language. The enrichment material provided at the end of some chapters is intended for students who are motivated to explore the ideas of the chapter beyond what is required at this stage. This material is meant to encourage deeper engagement and curiosity, and will not form part of formal evaluation.

Finally, the book includes ideas and approaches that may be new or challenging, even for teachers. It is perfectly acceptable if some aspects require reflection or further exploration. Opening such ideas for classroom discussion and approaching them as a co-learner can model intellectual curiosity and perseverance, setting a powerful example for students.

## Summary of Key Points

### Time for Exploration

- Regularly pose questions, problems, and challenges that encourage reasoning and discussion.
- Allow sufficient time for individual and group exploration.
- Foster an environment where mistakes are valued as a part of learning.

### About the Problems in the Book

- Exploratory problems aim to deepen conceptual understanding as well as support procedural fluency.
- Depth of engagement should take precedence over quantity of problems covered.

### Reading and Communication

- Encourage students to read, interpret and explain mathematical ideas in their own words.
- Promote discussion as a means to clarify thinking and build mathematical language.

### Right of Not Knowing

- Some ideas may not be immediately clear; this is a natural part of learning mathematics.
- Treat uncertainty as a starting point for inquiry and discussion, both for students and teachers.

## A NOTE TO STUDENTS

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As you embark on your journey of learning mathematics in Grade 9, it will be good to keep in mind that mathematics is not something to be watched from a distance, but something you learn by actively engaging with it. True understanding comes from thinking, questioning, exploring ideas, and sometimes struggling with them, much like a detective working through a puzzle.

As you work through this book, you will encounter new concepts, unfamiliar representations, and questions that may not have immediate answers. When this happens, pause and think. Try examples, look for patterns, draw diagrams, discuss with your classmates, and attempt to explain your reasoning. These processes are central to learning mathematics at this level.

Some questions in the book may be accompanied by answers or hints. Even then, you are encouraged to first attempt the problems on your own or with peers. The effort you invest in thinking through a problem will deepen your understanding and make the learning experience more meaningful.

You will notice ‘Think and Reflect’ questions throughout the textbook. These signal opportunities to explore and think more deeply. Some questions are meant to be discussed with classmates, while others invite creative or extended thinking. Engaging seriously with these will help you develop confidence and flexibility in your mathematical thinking.

At this stage, you will also begin to encounter explanations and justifications that explain why something works, not just how. Do not worry if this take time to make sense—understanding develops gradually through reflection and discussion.

Most importantly, remember that not understanding something immediately is perfectly normal. Mathematics is learned through persistence, curiosity, and thoughtful engagement. Enjoy the process of figuring things out, and allow yourself the time to grow as a mathematical thinker.

# Constitution of India

## Part IV A (Article 51 A)

### Fundamental Duties

It shall be the duty of every citizen of India —

- (a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
- (b) to cherish and follow the noble ideals which inspired our national struggle for freedom;
- (c) to uphold and protect the sovereignty, unity and integrity of India;
- (d) to defend the country and render national service when called upon to do so;
- (e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
- (f) to value and preserve the rich heritage of our composite culture;
- (g) to protect and improve the natural environment including forests, lakes, rivers, and wildlife, and to have compassion for living creatures;
- (h) to develop the scientific temper, humanism and the spirit of inquiry and reform;
- (i) to safeguard public property and to abjure violence;
- (j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;
- \* (k) who is a parent or guardian, to provide opportunities for education to his child or, as the case may be, ward between the age of six and fourteen years.

**Note:** The Article 51A containing Fundamental Duties was inserted by the Constitution (42nd Amendment) Act, 1976 S.11 (with effect from 3 January 1977).

\* (k) was inserted by the Constitution (86th Amendment) Act, 2002 S.4 (with effect from 1 April 2010).

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## GANITA IN INDIA

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यथा शिखा मयूराणां, नागानां मणयो तथा।  
तद्वद् वेदाङ्गशास्त्राणां, गणितं मूर्धनि स्थितम्॥

Yathā śikhā mayūrāṇām, nāgānām maṇayo tathā।  
Tadvad vedāṅgaśāstrāṇām, gaṇitaṁ mūrdhani sthitam॥

*Like the crest on the head of a peacock,  
Like the gem on the head of a snake,  
So is mathematics too at the head of all knowledge.*

A verse from the *Vedāṅga Jyotiṣa*, which is amongst the world's very oldest texts on astronomy, going back thousands of years.