

MATHEMATICS

Textbook for Class XI



11075



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

11076 – MATHEMATICS

Textbook for Class XI

ISBN 81-7450-486-9

First Edition

February 2006 Phalguna 1927

Reprinted

October 2006, November 2007,
December 2008, December 2009,
January 2011, February 2012,
December 2012, November 2013,
December 2014, May 2016,
December 2016, December 2017,
January 2019, August 2019,
January 2021 and November 2021

Revised Edition

November 2022 Agrahayan 1944

PD 500T BS

© National Council of Educational
Research and Training, 2006, 2022

₹ 210.00

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 110 016
and printed at Abhimaani Publications
Limited, Plot No. 2/4, Dr. Rajkumar
Road, Rajaji Nagar, Bengaluru - 560 010

ALL RIGHTS RESERVED

- ❑ No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.
- ❑ This book is sold subject to the condition that it shall not, by way of trade, be lent, re-sold, hired out or otherwise disposed of without the publisher's consent, in any form of binding or cover other than that in which it is published.
- ❑ The correct price of this publication is the price printed on this page. Any revised price indicated by a rubber stamp or by a sticker or by any other means is incorrect and should be unacceptable.

OFFICES OF THE PUBLICATION DIVISION, NCERT

NCERT Campus
Sri Aurobindo Marg
New Delhi 110 016 Phone : 011-26562708

108, 100 Feet Road
Hosdakere Halli Extension
Banashankari III Stage
Bengaluru 560 085 Phone : 080-26725740

Navjivan Trust Building
P.O. Navjivan
Ahmedabad 380 014 Phone : 079-27541446

CWC Campus
Opp. Dhankal Bus Stop
Panihati
Kolkata 700 114 Phone : 033-25530454

CWC Complex
Maligaon
Guwahati 781 021 Phone : 0361-2674869

Publication Team

Head, Publication Division : Anup Kumar Rajput

Chief Production Officer : Arun Chitkara

Chief Business Manager : Vipin Dewan

Chief Editor (In charge) : Bijnan Sutar

Production Assistant : Om Prakash

Cover and Layout

Arvinder Chawla

Foreword

The National Curriculum Framework (NCF), 2005, recommends that children's life at school must be linked to their life outside the school. This principle marks a departure from the legacy of bookish learning which continues to shape our system and causes a gap between the school, home and community. The syllabi and textbooks developed on the basis of NCF signify an attempt to implement this basic idea. They also attempt to discourage rote learning and the maintenance of sharp boundaries between different subject areas. We hope these measures will take us significantly further in the direction of a child-centred system of education outlined in the National Policy on Education (1986).

The success of this effort depends on the steps that school principals and teachers will take to encourage children to reflect on their own learning and to pursue imaginative activities and questions. We must recognise that given space, time and freedom, children generate new knowledge by engaging with the information passed on to them by adults. Treating the prescribed textbook as the sole basis of examination is one of the key reasons why other resources and sites of learning are ignored. Inculcating creativity and initiative is possible if we perceive and treat children as participants in learning, not as receivers of a fixed body of knowledge.

These aims imply considerable change in school routines and mode of functioning. Flexibility in the daily time-table is as necessary as rigour in implementing the annual calendar so that the required number of teaching days are actually devoted to teaching. The methods used for teaching and evaluation will also determine how effective this textbook proves for making children's life at school a happy experience, rather than a source of stress or boredom. Syllabus designers have tried to address the problem of curricular burden by restructuring and reorienting knowledge at different stages with greater consideration for child psychology and the time available for teaching. The textbook attempts to enhance this endeavour by giving higher priority and space to opportunities for contemplation and wondering, discussion in small groups, and activities requiring hands-on experience.

The National Council of Educational Research and Training (NCERT) appreciates the hard work done by the Textbook Development Committee responsible for this

book. We wish to thank the Chairperson of the advisory group in Science and Mathematics, Professor J.V. Narlikar and the Chief Advisor for this book Professor P.K. Jain for guiding the work of this committee. Several teachers contributed to the development of this textbook; we are grateful to their principals for making this possible. We are indebted to the institutions and organisations which have generously permitted us to draw upon their resources, material and personnel. We are especially grateful to the members of the National Monitoring Committee, appointed by the Department of Secondary and Higher Education, Ministry of Human Resource Development under the Chairpersonship of Professor Mrinal Miri and Professor G.P. Deshpande, for their valuable time and contribution. As an organisation committed to the systemic reform and continuous improvement in the quality of its products, NCERT welcomes comments and suggestions which will enable us to undertake further revision and refinement.

New Delhi
20 December 2005

Director
National Council of Educational
Research and Training

Rationalisation of Content in the Textbooks

In view of the COVID-19 pandemic, it is imperative to reduce content load on students. The National Education Policy 2020, also emphasises reducing the content load and providing opportunities for experiential learning with creative mindset. In this background, the NCERT has undertaken the exercise to rationalise the textbooks across all classes. Learning Outcomes already developed by the NCERT across classes have been taken into consideration in this exercise.

Contents of the textbooks have been rationalised in view of the following:

- Overlapping with similar content included in other subject areas in the same class
- Similar content included in the lower or higher class in the same subject
- Difficulty level
- Content, which is easily accessible to students without much interventions from teachers and can be learned by children through self-learning or peer-learning
- Content, which is irrelevant in the present context

This present edition, is a reformatted version after carrying out the changes given above.

www.dreamtopper.in

Textbook Development Committee

CHAIRPERSON, ADVISORY GROUP IN SCIENCE AND MATHEMATICS

J.V. Narlikar, *Emeritus Professor*; Chairman, Advisory Committee Inter University Centre for Astronomy & Astrophysics (IUCCA), Ganeshkhind, Pune University, Pune

CHIEF ADVISOR

P.K. Jain, *Professor*; Department of Mathematics, University of Delhi, Delhi

CHIEF COORDINATOR

Hukum Singh, *Professor*; DESM, NCERT, New Delhi

MEMBERS

A.K. Rajput, *Associate Professor*, RIE Bhopal, M.P.

A.K. Wazalwar, *Associate Professor*, DESM NCERT, New Delhi

B.S.P. Raju, *Professor*, RIE Mysore, Karnataka

C.R. Pradeep, *Assistant Professor*, Department of Mathematics, Indian Institute of Science, Bangalore, Karnataka.

Pradepto Hore, *Sr. Maths Master*, Sarla Birla Academy Bangalore, Karnataka.

S.B. Tripathy, *Lecturer*, Rajkiya Pratibha Vikas Vidyalaya, Surajmal Vihar, Delhi.

S.K.S. Gautam, *Professor*, DESM, NCERT, New Delhi

Sanjay Kumar Sinha, *P.G.T.*, Sanskriti School Chanakyapuri, New Delhi.

Sanjay Mudgal, *Lecturer*, CIET, New Delhi

Sneha Titus, *Maths Teacher*, Aditi Mallya School Yelaharika, Bangalore, Karnataka

Sujatha Verma, *Reader in Mathematics*, IGNOU, New Delhi.

Uaday Singh, *Lecturer*, DESM, NCERT, New Delhi.

MEMBER-COORDINATOR

V.P. Singh, *Associate Professor*, DESM, NCERT, New Delhi

Acknowledgements

The Council gratefully acknowledges the valuable contributions of the following participants of the Textbook Review Workshop: P. Bhaskar Kumar, *P.G.T.*, Jawahar Navodaya Vidyalaya, Ananthpur, (A.P.); Vinayak Bujade, *Lecturer*, Vidarbha Buniyadi Junior College, Sakkardara Chowk Nagpur, Maharashtra; Vandita Kalra, *Lecturer*, Sarvodaya Kanya Vidyalaya Vikashpuri District Centre, New Delhi; P.L. Sachdeva Deptt. of Mathematics, Indian Institute of Science, Bangalore, Karnataka; P.K. Tiwari *Assistant Commissioner (Retd.)*, Kendriya Vidyalaya Sangathan; Jagdish Saran, Department of Statistics, University of Delhi; Quddus Khan, *Lecturer*, Shibli National P.G. College Azamgarh (U.P.); Sumat Kumar Jain, *Lecturer*, K.L. Jain Inter College Sasni Hathras (U.P.); R.P. Gihare, *Lecturer* (BRC), Janpad Shiksha Kendra Chicholi Distt. Betul (M.P.); Sangeeta Arora, *P.G.T.*, A.P.J. School Saket, New Delhi; P.N. Malhotra, *ADE* (Sc.), Directorate of Education, Delhi; D.R. Sharma, *P.G.T.*, J.N.V. Mungespur, Delhi; Saroj, *P.G.T.* Government Girls Sr. Secondary School, No. 1, Roop Nagar, Delhi; Manoj Kumar Thakur, *P.G.T.*, D.A.V. Public School, Rajender Nagar, Sahibabad, Ghaziabad (U.P.) and R.P. Maurya, *Reader*, DESM, NCERT, New Delhi.

Acknowledgements are due to Professor M. Chandra, *Head*, Department of Education in Science and Mathematics for her support.

The Council acknowledges the efforts of the Computer Incharge, Deepak Kapoor; Rakesh Kumar, Kamlesh Rao and Sajjad Haider Ansari, D.T.P. Operators; Kushal Pal Singh Yadav, Copy Editor and Proof Readers, Mukhtar Hussain and Kanwar Singh.

The contribution of APC–Office, administration of DESM and Publication Department is also duly acknowledged.

Contents

<i>Foreword</i>	<i>iii</i>
<i>Rationalisation of Content in the Textbooks</i>	<i>v</i>
1. Sets	1
1.1 Introduction	1
1.2 Sets and their Representations	1
1.3 The Empty Set	5
1.4 Finite and Infinite Sets	6
1.5 Equal Sets	7
1.6 Subsets	9
1.7 Universal Set	12
1.8 Venn Diagrams	13
1.9 Operations on Sets	13
1.10 Complement of a Set	18
2. Relations and Functions	24
2.1 Introduction	24
2.2 Cartesian Product of Sets	24
2.3 Relations	28
2.4 Functions	30
3. Trigonometric Functions	43
3.1 Introduction	43
3.2 Angles	43
3.3 Trigonometric Functions	49
3.4 Trigonometric Functions of Sum and Difference of Two Angles	57
4. Complex Numbers and Quadratic Equations	76
4.1 Introduction	76
4.2 Complex Numbers	76

4.3	Algebra of Complex Numbers	77
4.4	The Modulus and the Conjugate of a Complex Number	81
4.5	Argand Plane and Polar Representation	83
5.	Linear Inequalities	89
5.1	Introduction	89
5.2	Inequalities	89
5.3	Algebraic Solutions of Linear Inequalities in One Variable and their Graphical Representation	91
6.	Permutations and Combinations	100
6.1	Introduction	100
6.2	Fundamental Principle of Counting	100
6.3	Permutations	104
6.4	Combinations	114
7.	Binomial Theorem	126
7.1	Introduction	126
7.2	Binomial Theorem for Positive Integral Indices	126
8.	Sequences and Series	135
8.1	Introduction	135
8.2	Sequences	135
8.3	Series	137
8.4	Geometric Progression (G.P.)	139
8.5	Relationship Between A.M. and G.M.	144
9.	Straight Lines	151
9.1	Introduction	151
9.2	Slope of a Line	152
9.3	Various Forms of the Equation of a Line	159
9.4	Distance of a Point From a Line	164
10.	Conic Sections	176
10.1	Introduction	176
10.2	Sections of a Cone	176
10.3	Circle	179

10.4	Parabola	182
10.5	Ellipse	187
10.6	Hyperbola	195
11.	Introduction to Three Dimensional Geometry	208
11.1	Introduction	208
11.2	Coordinate Axes and Coordinate Planes in Three Dimensional Space	209
11.3	Coordinates of a Point in Space	209
11.4	Distance between Two Points	211
12.	Limits and Derivatives	217
12.1	Introduction	217
12.2	Intuitive Idea of Derivatives	217
12.3	Limits	220
12.4	Limits of Trigonometric Functions	234
12.5	Derivatives	239
13.	Statistics	257
13.1	Introduction	257
13.2	Measures of Dispersion	259
13.3	Range	259
13.4	Mean Deviation	259
13.5	Variance and Standard Deviation	271
14.	Probability	289
14.1	Event	289
14.2	Axiomatic Approach to Probability	295
	Appendix 1: Infinite Series	314
A.1.1	Introduction	314
A.1.2	Binomial Theorem for any Index	314
A.1.3	Infinite Geometric Series	316
A.1.4	Exponential Series	318
A.1.5	Logarithmic Series	321

Appendix 2: Mathematical Modelling	323
A.2.1 Introduction	323
A.2.2 Preliminaries	323
A.2.3 What is Mathematical Modelling	327
<i>Answers</i>	335
<i>Supplementary Material</i>	357

www.dreamtopper.in