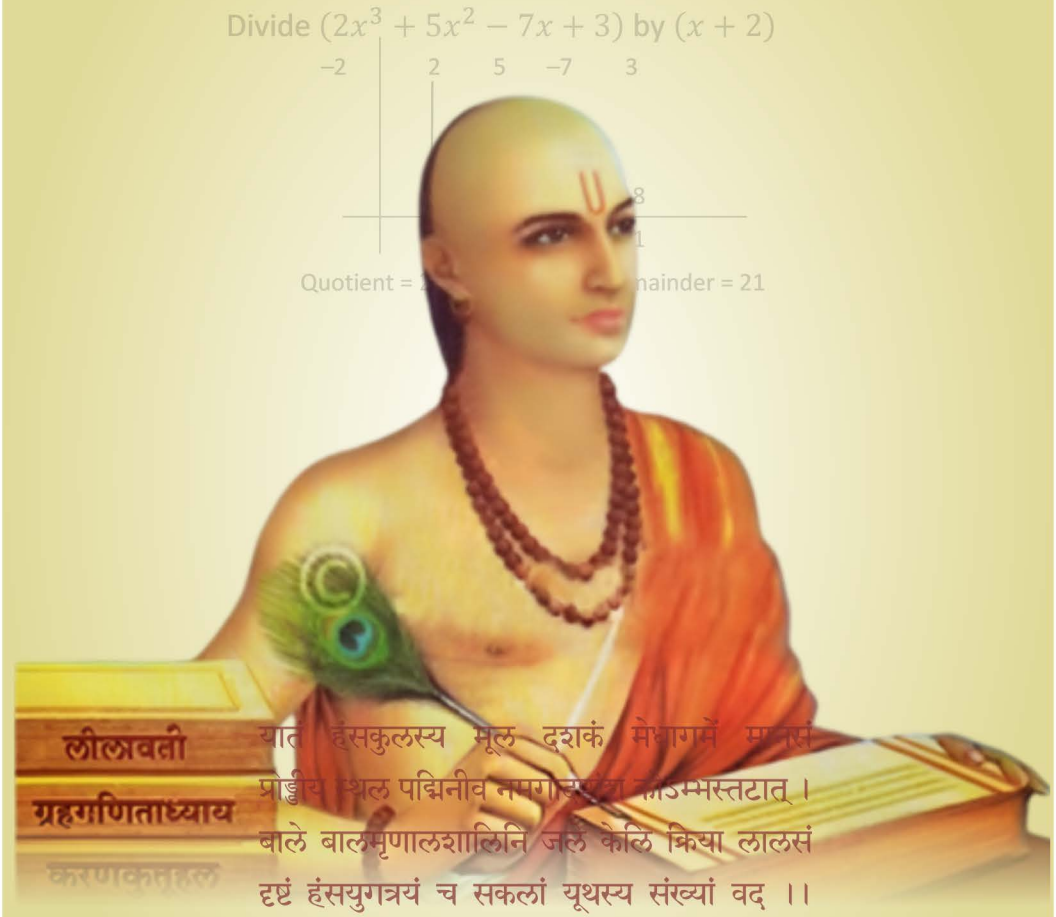
VEDIC ALGEBRA

(Parāvartya - Yojayet)



।। Lilavati LXXV ।।

Publisher

Centre for Vedic Sciences
Banaras Hindu University
Varanasi-221005

VEDIC ALGEBRA

(Parāvartya - Yojayet)



By

Dr. S. L. Maurya

M.A., Ph.D.

Guest Faculty, Centre for Vedic Sciences

Banaras Hindu University

Editor

Prof. Upendra Kumar Tripathi

Coordinator, Centre for Vedic Sciences

and Professor of Veda, Sanskrit Vidya Dharm Vigyan Sankaya

Banaras Hindu University



Publisher

Centre for Vedic Sciences

Banaras Hindu University,

Varanasi -221005

© Publisher

First Edition : 2024

Writer

Dr. S. L. Maurya
M.A., Ph.D.
Guest Faculty, Centre for Vedic Sciences
Banaras Hindu University

Editor

Prof. Upendra Kumar Tripathi
Coordinator, Centre for Vedic Sciences
and Professor of Veda, Sanskrit Vidya Dharm Vigyan Sankaya
Banaras Hindu University

Published by

Centre for Vedic Sciences
Banaras Hindu University, Varanasi - 221005
Phone: 0542-2368372 (Office)
Email: vvkendra@bhu.ac.in

ISBN : 978-81-951360-4-9

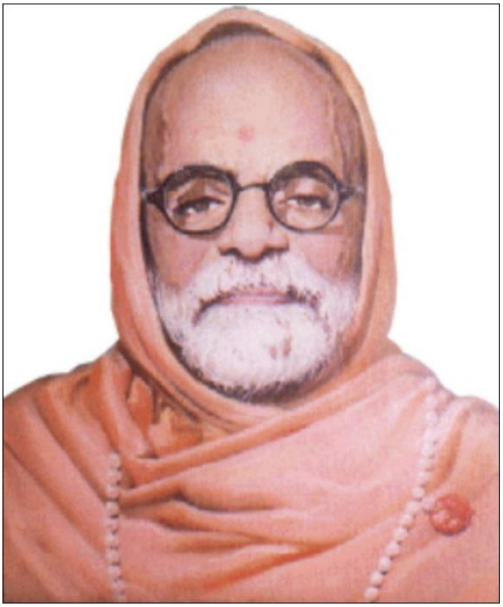
Price: 400 /-

All rights reserved. No part of this work may be copied, adapted, abridged or translated, stored in any retrieval system, computer system, photographic or other system or transmitted in any form by any means whether electronic, mechanical, digital, optical, photographic or otherwise without a prior written permission of the copyright holders Centre for Vedic Science, Banaras Hindu University, Varanasi, UP, India.

While every effort has been made to avoid any mistake or omission, this publication is being sold on the condition and understanding that neither editors nor the publishers or printers would be liable in any manner to any person by reason of any mistake or omission in this publication or for any action taken or omitted to be taken on advice rendered or accepted on the basis of this work. Rights of Publication reserved with the Publishers.

Published with financial support by the Department of Religious Affairs, Government of Uttar Pradesh

Jagadguru Śaṅkarācārya Svāmī Bhāratīkṛṣṇa Tīrthaji



(1884 - 1960)

श्रीशंकराचार्यपदाधिरूढ
श्रीभारतीकृष्णनिजाभिधानम्।
जगद्गुरुणां चरणारविन्दं
समर्चयामीप्सित सर्वसिद्धयै।।

EDITORIAL

I feel overwhelmed in putting forth the book "Vedic Algebra (Parāvartya Yojayet)" published by the Vedic Vigyan Kendra, Banaras Hindu University, Varanasi to the beginners of Vedic Mathematics. The Mathematical structures enshrined in ancient Sanskrit literatures as rediscovered by Swami Bharati Krishna Tirth Ji and having its genesis on tricks, techniques and patterns is Vedic Mathematics. Such texts have been compiled in the form of Sutras dealing with almost all disciplines of mathematics having their applications in modern sciences also. The Sutras circumvent the computational part of mathematics in easy, less time taking and error-free ways. Even people having not much interest in mathematics are charmed towards the Vedic computational approaches. In Vedic mathematics the systematic procedures vary from problem to problem and as such one must practice all established methods so that the specific approach could be followed to get the solution of the problem in few steps.

The Sulbasutras belonging to the Kalpvedang are attributed by the Maharshis of Indian origin in first millennium B.C. In Sanskrit literature 'Sulba' stands for Rajju (Cord) and 'Sutra' the rules for measurement. During the Vedic era 'Angulas' were used as one of the units of measurement and accordingly the cords were used for shaping different structures for performing rites. The ‘Praman (length or quantity)’, a variable, is frequently used in most of the Sutras. On the other hand, for special structures, the shapes and sizes were decided first by the priests and then the respective Pramanas were computed. Determining Pramanas under the constraints gave rise to the equations. The science of study of variable Pramanas under specified rules and formation of equations followed by their solutions is a part of algebra. Gradually, letters and some other symbols were used to represent the variable Pramanas and expressions there on which became symbolic algebra. The modern form of algebra is nothing but symbolic algebra. The successive advancements in this respect by the Indian mathematicians is narrated hereunder briefly.

The Ganit Pada of the book Aryabhatia authored by the mathematician Aryabhata (476 CE–550 CE) deals with simple, simultaneous, quadratic and indeterminate equations but in words form along with arithmetic and mensuration. Bhaskaracharya I (600 CE–680 CE), the Indian mathematician and astronomer used symbols to represent the ratio of two sides of a right triangle in trigonometry. The rules expounded for computing the values of these ratios yield better approximation those that obtained by Aryabhata. Brahmagupta (598 CE–

668 CE) was the author of the famous book *'Brahmasphutsiddhant'* dealing with astronomy, algebra, geometry and trigonometry. Bhaskaracharya II (1114–1185) used decimal number system in his texts. The unknown quantities were represented by letters but not in present form. He devised the methods for the solution of equations in ways better than his predecessors. From 16th century onwards the mathematicians worldwide started using symbols to represent unknown quantities and equations too were expressed in terms of symbols. *'Bijganit'* was treatise on algebra by Bhaskara II. It is the second volume of *'Siddhant Shiromani'* alongside Lilavati, Grahganit and Goladhyaya.

The present book is an endeavor to make the learners understand the fundamentals of algebra as narrated by the Rishis of ancient period and get apprised of the traditional antiquities. This book is no doubt a masterpiece of algebra which will pave the way for the subject's enrichment in the future.

I express my thanks to the patron Prof. Sudhir Kumar Jain, the Hon'ble vice chancellor, Banaras Hindu University, Varanasi for providing facilities for the upliftment of this Centre. I thank Prof. Vijay Kumar Shukla, the Rector, Banaras Hindu University, for extending cooperation in all respect for carrying on the task of publication of this book. My heartiest thanks are due to Prof. Arun Kumar Singh, the Registrar, B.H.U. Varanasi for providing all round support. I am grateful to Dr. Abhay Kumar Thakur, Finance Officer, B.H.U. for necessary guidance and support. I am greatly obliged to Shri Anand Vikram Singh, JR (development) for necessary assistance and encouragement. I extend my heartiest good wishes for the successful publication of the book which will guide the readers to comprehend the concept of sciences as inscribed in Vedic literature. I owe immensely to the department of Religious Affairs, Uttar Pradesh Government for providing financial help to publish this book. My heartiest thanks are due to Dr. Daya Shankar Tripathi for suggestions, encouragement and corrections of the manuscript. The Authors of the books, used as references, deserve my thanks for inspiration to carry on this herculean task.

Prof. Upendra Kumar Tripathi
Coordinator, Centre for Vedic Sciences
Banaras Hindu University, Varanasi

PREFACE

It gives me immense pleasure to dedicate this book to the readers keenly interested in learning Vedic approaches in modern form of symbolism in algebra. The symbolic algebra as of today emerged around 16th century. The origin of algebra dates to the scripting of Vedas or even before that but it was not in symbolic form. The constraints to determine unknown quantities were expressed in words. Gradually symbolism got introduced to denote the quantities and the relations among them. The word problems to determine the value of a quantity could get expressed in symbolic form as equations. The Siddhant Shiromani of Bhaskaracharya II has four volumes Leelavati, Bijganit, Grahganit and Goladhyaya. It is presumed that the algebra in present form could started taking shape during the period of Bhaskara II.

The first unit is on the four fundamental operations and the method adopted for addition and subtractions is undoubtedly simpler than the present traditional method. The Sutras *'Nikhilam'* and *'Urdhvatiryakbhyam'* have been used to obtain the product of two or more expressions. For division of two algebraic expressions *'Paravartya'* Sutra has been applied which yields simple, less time taking and error free results. In second unit of factorizations of algebraic expressions *'Anurupyen'* and *'Adyamadyenantyamantyen'* Sutras have been used. The Sutra *'Gunitsamuccyayah Samuccaya Gunitah'*, not only checks the correctness of the factors but facilitates find the factors of higher degrees of polynomials.

The third unit comprises H.C.F. and L.C.M. of algebraic expressions. For finding H.C.F. of two expressions *'Lopanastha-panabhyam'* Sutra has been incorporated and the procedure is simpler than that of conventional division method. L.C.M. of the expressions is calculated after finding their H.C.F. The mixed operations comprising four fundamental operations to reflect in this unit. In the fourth unit one-line solutions of simple equations using *'Paravartya Yojayet'* Sutra has been introduced. Quite a few special cases of equations have been dealt along with other forms which are transformed to these forms. Solutions of quadratic equations have been computed using calculus (derivatives) method which of course coincides with Shreedharacharya method. The nature of roots of

quadratic equations and the algebra there on has been discussed in detail. The solution of cubic equations using factor and *'Puranabhyam'* methods have been dealt with. Alongside, the relation among the roots and the coefficients of the terms of the equations too has been established effectively.

The fifth unit is on Partial Fractions. Splitting the rational expression into partial fraction is the process of expressing it as the sum of the fractions. Disguised forms too have been taken into consideration and values of the unknowns have been obtained in easy way without many computations. Resolution of the rational expression into partial fraction facilitates obtaining its integration in easy way. The sixth unit deals with the binomial theorem. The Meruprastar has been used to determine the coefficients of terms of binomial expansions. The related results and properties too have been discussed in detail.

At the end of each unit a set of exercises has been provided to the learners for practice. Efforts are on to make the Vedic Sutras more adoptive in wider range. Elementaries in the beginning of each section help comprehend related basics and subsequent applications there on.

I extend my profound gratitude to the editor Prof. Upendra Kumar Tripathi, coordinator, Centre for Vedic Sciences and Professor, Department of Veda, Faculty of Sanskrit Vidya Dharm Vigyan, Banaras Hindu University Varanasi, whose cooperation, guidance, and encouragement boosted my morale to furbish the work in the form of this book. I express my deepest thanks to Dr. Daya Shankar Tripathi for valuable suggestions to consolidate the work in the present form. The valuable suggestions from readers end will be gracefully accepted. Computational errors, if any, should be brought to our notice so that same can be removed in future editions.

S. L. Maurya

CONTENT

S.N.	Particular	Page No.
	Editorial	*i*
	Preface	*ii*
	Content	*v*
	Introduction	*vii*
Unit 1 – Fundamental Operations		**01-24**
1.1	Brief introduction	01
1.2	Recapitulations	02
1.3	Finding the value of an expression	04
1.4	Addition and subtraction of expressions	04
1.5	Exercises	08
1.6	Multiplication	10
1.7	Exercises	15
1.8	Division	16
1.9	Exercises	24
Unit 2 – Factorization		**25-40**
2.1	Factorization of Quadratic Polynomials.	25
2.2	Exercises	29
2.3	Factorization of homogeneous Expressions	30
2.4	Exercises	33
2.5	Factorization of cubic Polynomials	34
2.6	Exercises	40
Unit 3 - H.C.F. and L.C.M.		**41-54**
3.1	Highest Common Factor	41
3.2	Lowest Common Multiple	42
3.3	Exercises	47

3.4	Mixed Operations	49
3.5	Exercises	52
Unit 4 - Equations		**55-109**
4.1	Simple equations	55
4.2	Exercises	69
4.3	Simultaneous Linear Equations	72
4.4	Special type of Simultaneous Linear equations.	74
4.5	Exercises	81
4.6	Quadratic Equations	82
4.7	Nature of Roots of the Equation	85
4.8	Special forms of the equation	89
4.9	Equations reducible to quadratic forms	95
4.10	Exercises	99
4.11	Cubic Equations	103
4.12	Exercises	108
Unit 5 - Partial Fractions		**110-122**
5.1	Introduction	110
5.2	Elementaries	110
5.3	Forms of Partial fractions	111
5.4	Exercises	120
Unit 6 - Binomial Theorem		**123-133**
6.1	Factorial Notations	123
6.2	Fundamental Theorem of Counting	124
6.3	Binomial Theorem	125
6.4	Properties	126
6.5	Exercises	131
	References	134



Rs. 400 /-

Publisher
Centre for Vedic Sciences
Banaras Hindu University, Varanasi-05
E-mail: vvkendra@bhu.ac.in, Phone: 0542-2368372 (Office)

9 788195 136049