

**F.Y.B.Sc.**  
(Computer Science)  
Semester-I  
Course Code: MTS-1101 T  
As per NEP w.e.f. 2024-25

**2** Credits

# Matrix Algebra

Arun S. Pandhari



Principal  
Tujaram Chaturchand College  
Baramati



# Matrix Algebra

**Arun S. Pandhari**

M.Sc., M.Ed., M.Phil

(Ex.) HOD, P.G. Department of Mathematics,  
T.C. College, Baramati.

**SPECIMEN COPY**  
For Review & Recommendation  
**VISION PUBLICATIONS**  
M.: 9960959922, 9028653050

2013



Innovation Throughout

**VISION PUBLICATIONS**

Pune



Tujaram

Principal

Tujaram Chaturchand College  
Baramati



# Dedicated

to

My wife Anjali

&

My son Dr. Abhijit

Who are constant sources of energy for me.

**Author**  
Arun S. Pandhari





# CONTENTS

<b>1. Matrices</b>	<b>1-62</b>
1. Matrix Operations.....	1-1
2. Elementary Matrices, Elementary Row Operations.....	1-33
3. Row Reduction and Echelon Forms.....	1-41
4. LU Factorization of Matrix.....	1-55
<b>2. Determinants</b>	<b>2-32</b>
1. Introduction to Determinants.....	2-1
2. Properties of Determinants.....	2-11
3. Determinant by Row Reduction.....	2-23
4. Determinant by Cofactor Expansion along any Row or Column.....	2-26
<b>3. Invertible Matrices</b>	<b>3-28</b>
1. The Inverse of a Matrix.....	3-1
2. Characterization of Invertible Matrices.....	3-13
3. To Find Inverse of a Matrix By Row Reduction.....	3-16
4. To find the Inverse of a Matrix by Adjoint Method.....	3-20
<b>4. Linear Equations</b>	<b>4-80</b>
1. Introduction.....	4-1
2. System of Linear Equations.....	4-1
3. The Matrix Equation $Ax = b$ .....	4-18
4. Gauss Elimination Method.....	4-41
5. Cramer's Rule.....	4-59
6. Application of LU-Decomposition to Solve System $Ax = b$ .....	4-69





Vision Publications titles are available at significant discounts when purchased in bulk for client gifts, sales promotion, and premiums. Special editions, including books with corporate logos, customized covers, as well as excerpts of existing books, can also be created in large quantities for special needs.

For details and discount information contact  
visionpublications@gmail.com, Tel.: 8830238610

  
Innovation Throughout  
**VISION PUBLICATIONS**

**Head Office**

Anand Bungalow, Road No. 10, Adarsh Colony, Tingrenagar. Pune-32.

**Sales Office**

39/1, Budhwar Peth, Appa Balwant Chowk, Pune - 2.

website: [www.visionpune.com](http://www.visionpune.com)

email: [visionpublications@gmail.com](mailto:visionpublications@gmail.com) / [info@visionpune.com](mailto:info@visionpune.com)

**Book Title**

Matrix Algebra

**Author**

Arun S. Pandhari

**Edition**

First: 2024

**ISBN**

978-93-94022-31-7

© All rights reserved by Vision Publications. No part of this book is to be reproduced or transmitted in any form, Electronic, Mechanical, Photocopy or any information stored in a retrieval system without prior permission in writing, from Vision Publications, nor be otherwise circulated in any form of binding or cover other than that in which it is published without a similar condition being imposed on the subsequent purchaser.


**Printer**

Yogiraj Binders: S.No. 10/2a, Ghule Industrial Estate, Nanded Village Road, Tal.: Haveli, Pune 41.

**Note:** Due care has been taken while editing, printing and binding of the book. Neither the editors nor publishers of the book hold any responsibility for any mistake that may have inadvertently crept in. If you notice any errors in the book and wish to report, please login to our website [www.visionpune.com](http://www.visionpune.com) and write comments on this book on the site. You can search this book by entering Book ID mentioned below. Thank you.

2108



  
Principal  
Tutjaram Chaturchand College  
Baramati



## Preface

It gives me great pleasure and satisfaction to present this text book on 'Matrix Algebra' for especially for F.Y.B.Sc.(Computer Science) Mathematics (2024 pattern) as per CBCS, SPPU, Pune.

This book is written according to the needs of the students. It is helpful to the professors teaching the subject. It is written according to the guidelines given by the Board of Studies in Mathematics at the University. The matter is presented in a simple and understandable language followed by various solved examples of all types. The book is divided into three parts - Introduction to Matrices, Linear Equations, and Determinants. At the end of each chapter, various problems are given for practicals which are to be solved using 'Maxima' software. The book is written as per the lines of the text-book recommended by the University.

Vision Publications has always given me the freedom and support to write several books for various standards which were widely accepted by the students and Professors community.

I am thankful to the staff of Vision. They have taken great efforts to publish this text book.

I also thank my wife, Prof. Mrs. Anjali and my son Dr. Abhijit (Canada) who are a constant source of energy for me.

Finally, I welcome the suggestions and criticism from all the readers.

Prof. Arun. S. Pandhari

[Author]





## About Author

**Mr. A.S. Pandhari** has worked as P.G. Head of Mathematics at Tuljaram Chaturchand College, Baramati (Pune). He has a long experience of 38 years of teaching Mathematics and Statistics from U.G. to P.G. classes. He is resident and past student of T.C. College. The college is Accredited A+ by NACC in 2017. He did his M.Sc. from University of Pune, B.Ed. from Regional College of Education Bhopal. He stood first at B.Ed. He has passed M.Ed., M.Phil from University of Pune. Has consistently first class career. His topics of interest are Pure Mathematics, Statistics and Education. He has written 21 textbooks at F.Y./S.Y. B.Sc and B.C.S. students on Calculus, Algebra, Operations Research, etc. Published more than 30 articles in Marathi on various popular Science subjects in Newspaper and in science magazines in Marathi. He has worked in the fields of Adult Education and Competitive Examination Guidance. He has a long experience of working on various University /State Govt. Committees.



## F.Y. B.Sc. (Computer Science)

### Sem-I

- Problem Solving using 'C' Programming
- Matrix Algebra
- Principles of Analog Electronics
- English
- EVS-I

### Sem-II

- Advanced C Programming
- Graph Theory
- Principles of Digital Electronics
- English
- EVS-II

+91 8830238610

[www.visionpune.com](http://www.visionpune.com)



RECOMMENDATIONS CATEGORIES DOWNLOADS COURSES OFFERS



| Computer Science | Management | Engineering |  
| Science Biotechnology | Entrance Guide |

## The Best Online Book Store For You

| BBA | BCA | B.Sc. | B.Sc. (Computer Science, Data  
Science, Information Technology) | MCM | MPM | M.Sc. |



ISBN : 978-93-94022-31-7



₹270/-

  
Innovation Throughout  
**VISION PUBLICATIONS**  
[www.visionpune.com](http://www.visionpune.com)  
[visionpublications@gmail.com](mailto:visionpublications@gmail.com)



  
Principal  
Tuljaram Chaturchand College  
Baramati