Fourth Edition

# Advanced Engineering Mathematics

R.K. Jain • S.R.K. Iyengar

Alpha Science

R.K. Jain □ S.R.K. Iyengar

# Advanced Engineering Mathematics

*Fourth Edition*



Alpha Science International Ltd.
Oxford, U.K.

**R.K. Jain** *(Retd.)*
Professor of Mathematics
Indian Institute of Technology, Delhi
New Delhi, India

**S.R.K. Iyengar** *(Retd.)*
Professor & Head
Department of Mathematics
Indian Institute of Technology, Delhi
New Delhi, India


**First Edition 2002**
**Second Edition 2003**
**Third Edition 2007**
**Fourth Edition 2014**

---

ALPHA SCIENCE INTERNATIONAL LTD.
7200 The Quorum, Oxford Business Park North
Garsington Road, Oxford OX4 2JZ, U.K.

**www.alphasci.com**



ISBN 978-1-84265-846-8

Printed in India

# Advanced Engineering Mathematics

*Fourth Edition*

To Our Parents

*Bhagat Ram Jain and Sampati Devi Jain*

&

*S.T.V. Raghavacharya and Rajya Lakshmi*

Whose memories had always been an inspiration

# Preface to the Fourth Edition

We sincerely thank the faculty members and the students of various Institutes and Engineering Colleges for their suggestions to improve the book.

Based on these suggestions, we have included the following new material.

(i) Condition number of a matrix and Singular Value Decomposition (Chapter 3).
(ii) Application of Z-transforms to find the sum of series (Chapter 17).
(iii) Cubic splines, B-splines, Romberg integration, Gauss quadrature rules and Two-point boundary value problems (Chapter 18)

We hope that the book in the present form includes most of the topics covered in the core courses for Engineering students.

We look forward to get more suggestions from the faculty members and the students to improve the book further.

**R.K. Jain**
**S.R.K. Iyengar**

# Preface to the First Edition

This book is based on the experience and the lecture notes of the authors while teaching mathematics courses to engineering students at the Indian Institute of Technology, Delhi for more than three decades. A number of available textbooks have been a source of inspiration for introduction of concepts and formulation of problems. We are thankful to the authors of these books for their indirect help.

This comprehensive textbook covers syllabus for two courses in Mathematics for engineering students in various Institutes, Universities and Engineering Colleges. The emphasis is on the presentation of the fundamentals and theoretical concepts in an intelligible and easy to understand manner.

Each chapter in the book has been carefully planned to make it an effective tool to arouse interest in the study and application of mathematics to solve engineering and scientific problems. Simple and illustrative examples are used to explain each theoretical concept. Graded sets of examples and exercises are given in each chapter, which will help the students to understand every important concept. The book contains 682 solved examples and 2984 problems in the exercises. Answers to every problem and hints for difficult problems are given at the end of each chapter which will motivate the students for self-learning. While some problems emphasize the theoretical concepts, others provide enough practice and generate confidence to use these concepts in problem solving. This textbook offers a logical and lucid presentation of both the theory and problem solving techniques so that the student is not lost in unnecessary details.

We hope that this textbook will meet the requirement and the expectations of the engineering students.

We will gratefully receive and acknowledge every comment, suggestion for inclusion/exclusion of topics and errors in the book, both from the faculty and the students.

We are grateful to our former teachers, colleagues and well wishers for their encouragement and valuable suggestions. We are also thankful to our students for their feed back. We are grateful to the authorities of IIT Delhi for providing us their support.

We extend our thanks to the editorial and the production staff of M/s Narosa Publishing House, in particular Mr. Mohinder Singh Sejwal for their care and enthusiasm in the preparation of this book.

Last, but not the least, we owe a lot to our family members, in particular, our wives Vinod Jain and Seetha Lakshmi whose encouragement and support had always been inspiring and rejuvenating. We appreciate their patience during our long hours of work day and night.

New Delhi
October 2001

**R.K. Jain**
**S.R.K. Iyengar**

# Contents