

Preface

The Institute of Mathematics for Industry (IMI), Kyushu University, is a relatively new institute that will soon mark the fourth anniversary of its founding. In April 2013, the IMI received official recognition from the Ministry of Education, Culture, Sports, Science and Technology as Japan's second Joint Usage/Research Center in mathematics following the Research Institute for Mathematical Sciences of Kyoto University. Given the title of Center for Collaborative Research in Advanced and Fundamental Mathematics for Industry, the breadth of IMI activities is widening in collaboration with the research community as a motivating force. The IMI is also the third national mathematical science research institute in Japan if we include the Institute of Statistical Mathematics under the Research Organization of Information and Systems. Members of the IMI are researchers in what would traditionally be called industrial mathematics, (theoretical) applied mathematics, and pure mathematics, and they are divided about evenly among these fields. In addition, most of these members are currently engaged in joint research with industry while also being responsible for educating students majoring in mathematics including those in Master's degree courses and Ph.D. programs. For this reason, I think it would be fair to say that this book has a feel different from a typical compilation on mathematical modeling.

This book is based on a Japanese-language version prepared exactly one year ago, but its text has been revised and enhanced while adding contributions from new members in IMI. Instead of summarizing its contents, I will here quote from the preface to the Japanese edition.

“This book has been achieved through the cooperation of IMI members as well as researchers in industry who have made time to give keynote addresses at research gatherings sponsored either solely or jointly by IMI or to speak at the IMI Colloquium held regularly on the third Wednesday of every month. The themes covered in the book were selected according to the specialties and interests of each author, with attention given to one or more problems within each theme. The idea here was to create a guide for solving those problems through mathematical modeling. The world of applied mathematics and industrial mathematics is, of course, quite vast, and only a few themes from that world are taken up in this book. The purpose of the book, however, is to introduce those fields of mathematics—even if only a small portion of that world—that are now contributing to other scientific fields and to industry and that have the potential of contributing in the

future. The readers that we have in mind begin with undergraduate students and graduate students with an interest in mathematics and mathematical science, followed by individuals in industry and finally researchers/faculty members in various fields including mathematics. It is with this order in mind that an editorial policy was established. In particular, the authors were asked to prepare their manuscripts assuming that readers would have a level of knowledge typical of second- and third-year undergraduate students majoring in mathematics for the Japanese standard.

“Plans for publishing this book go back to the preparatory stage in the founding of IMI, but it has been a matter of ‘easier said than done’. Nevertheless, an editorial committee for preparing the book was established in IMI in April of last year with Prof. Ryuei Nishii taking on the responsibilities of chairman. The result of this committee’s efforts was a book consisting of 36 chapters.

“Although I cannot say for sure that the contents of this book have completely satisfied our objective here, I sincerely hope that it finds its way into the hands of many readers. The publishing of this book is, in a way, an experimental endeavor, and we plan to use the results that we have achieved here as a basis for enhancing the content of next year’s edition.”

All of us at the IMI would be greatly pleased if this book created through the process described above were to breathe new life, if even slightly, into the research of industrial mathematics and mathematical modeling. At the same time, we look forward to the frank opinions and comments offered by reviewers and readers of this book.

March 2014

Masato Wakayama
Director, Institute of Mathematics for Industry
Kyushu University
Fukuoka, Japan

Preface

The purpose of this book is to introduce those fields of mathematics that are contributing to other fields and to industry and that have the potential of contributing in the future. The readers targeted by the book are upper-level undergraduate students, graduate students, and corporate individuals. The six people responsible for editing the Basic Volume and Applied Volume of the book and the person in charge of overall editing made up the Editorial Committee, and all members of the Institute of Mathematics for Industry (IMI) and individuals from industry and academia having a deep relationship with IMI made contributions. The members of the Editorial Committee are listed below.

Algebra: Takayuki Ochiai (IMI, Kyushu University)

Geometry: Miyuki Koiso (IMI, Kyushu University)

Analysis: Shin-ichiro Ei (IMI, Kyushu University, now at Hokkaido University)

Probability and Statistics: Tomoyuki Shirai (IMI, Kyushu University)

Applied Mathematics: Ryuei Nishii (IMI, Kyushu University)

Application of Mathematics: Kanzo Okada (IMI, Kyushu University)

Overall Editing: Shingo Saito (Faculty of Arts and Science, Kyushu University)

On reading the submitted manuscripts, we could not help but be reminded of the wide dynamic range of mathematics and the great potential for its application to other fields and industry. We feel confident that the goal of publishing this book—to help others become more knowledgeable about the great possibilities of mathematical modeling—will be achieved, and it is our hope that this book and its individual articles will prove useful in a variety of situations and scenarios. Finally, we would like to extend our deep appreciation to those in industry and academia who took time from their busy schedules to prepare manuscripts for this book.

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Ryuei Nishii

A Mathematical Approach to Research Problems of
Science and Technology
Theoretical Basis and Developments in Mathematical
Modeling

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