

# Preface

This book *Applied Dynamics* is the revised English edition of the third edition of the German book *Technische Dynamik* originally published in 1986. The second and third editions have been co-authored by Peter Eberhard, too. The present English edition was encouraged by Nathalie Jacobs from Springer-Verlag, who deserves our sincere thanks. A draft translation of the third edition was prepared by Aaron Kuchle. Then, the authors revised the book and added to the many German references appropriate English books and papers, too.

In the last decades, applied dynamics has been incorporated into many new areas beyond its original applications in machine and vehicle dynamics. Models of robot dynamics are being successfully exploited in biomechanics, three-dimensional hinges are helping in the development of middle ear prostheses, and contact models for a few bodies are also being utilized for systems of a great number of particles. At the same time, model-based design of control-systems requires low-dimensional systems as provided by multibody dynamics. Complex models with finite elements can be represented with new methods of model reduction under given error limits. Complex models, also containing tire models of vehicles, are also being used, e.g., in the control of self-balancing Segway scooters. Moreover, efficient models are indispensable for the rapidly developing field of simulation technology.

All these new challenges and methods require extensive knowledge of the foundations of applied dynamics which remain just as relevant as ever for academic education. Lectures at universities as well as continuing education in industry have the essential task in common, namely the axiomatic, computer-based modelling of mechanical and mechatronic systems, what requires advanced applied dynamics. The structure and organization of the book have proved to be very effective, so these have been kept unchanged in the English edition. Moreover, we preserved the 43 *Examples* completely integrated in the 8 Chapters of the book. These *Examples* show educational applications of the fundamentals presented but they can be also used as problems for self-study. However, the opportunity was taken to correct printing errors, to revise notation, and to undertake many other alterations. In particular, the section on Beam System has been renamed to Flexible Systems,

and it allows the reader access to further literature including the Floating Frame of References Formulation and the Absolute Nodal Coordinate Formulation.

We would like to thank our many attentive readers, our colleagues and coworkers at the Institute for Engineering and Computational Mechanics as well as our students for their suggestions and inquiries, which have exerted great influence in the revision of the manuscript and the changes of the drawings. We are pleased to receive comments and notifications of possible errors, which can never be completely avoided even after careful proofreading and which will be continuously documented on the book's website.<sup>1</sup> We hope that this book will continue to be useful in education and in engineering practice, and we wish all interested readers much success and satisfaction in their engagement with this fascinating topic.

Stuttgart, Germany  
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<sup>1</sup>[www.itm.uni-stuttgart.de/book\\_applied\\_mechanics](http://www.itm.uni-stuttgart.de/book_applied_mechanics)

# From the Preface to the First German Edition

This book emanated from the thankworthy encouragement of my revered teacher, Prof. Dr. Kurt Magnus. It is based on lectures on applied dynamics and machine dynamics given at the Technical University of Munich and the University of Stuttgart as well as research on robot dynamics during a sabbatical with the MAN New Technology Division in Munich.

Applied dynamics, a branch of engineering mechanics, is presently a widely ramified science with applications in machine and vehicle engineering, aerospace, and even control technology. An introductory textbook can therefore only present the foundations as well as selected examples. Yet it is a concern of this book, mainly written for engineers, to present the computational methods in use today on a common basis. For this purpose, we use analytical mechanics as a base, whereby the Lagrange version of the d'Alembert principle has proved to be particularly productive. It is thus possible to discuss the method of multibody systems, the method of finite elements, and the method of continuous systems in a consistent manner. This makes it possible for the student to reach a deeper understanding with less effort. Also, the practicing engineer will be in a better position to assess his calculation results.

The book is divided into nine chapters. In the introduction, the problem of modelling is discussed, while the second chapter is dedicated to kinematics. The basics of kinematics are described at great detail, since they are necessary not only in kinetics but also for the principles of analytical mechanics. In the third chapter, the basic ideas of kinetics are presented for the mass point, the rigid body, and the continuum. This is followed by the principles of mechanics in Chap. 4, where only those important for engineering applications will be discussed. Chapters 5–7 then deal in turn with multibody systems, finite element systems, and continuous systems. The equations of motion are converted in Chap. 8 into state equations, which are consistent for all mechanical systems. The ninth chapter deals with a few questions regarding numerical solution methods.

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