Preface

This volume contains notes based on lectures presented at the advanced course 'Structure-preserving Integrators in Nonlinear Structural Dynamics and Flexible Multibody Dynamics' held at the International Centre for Mechanical Sciences (CISM) in Udine, Italy, during October 7–11, 2013.

The objective of the five chapters in this volume is to provide insight into state-of-the-art numerical methods for nonlinear structural and flexible multibody dynamics. In the field of structural mechanics, finite element methods are commonly applied for the discretization in space. Due to the large dimension of the resulting semi-discrete system, one is typically content with second-order accurate schemes for the discretization in time.

Based on well-established time-stepping schemes for the linear regime, energy-momentum consistent schemes and energy dissipating variants thereof have been developed in the framework of nonlinear structural dynamics during the past 25 years. These schemes are known to possess superior numerical stability and robustness properties when compared to standard methods.

The chapter written by I. Romero provides a general overview of high-frequency dissipative integrators for linear and nonlinear elastodynamics. If the controllable numerical dissipation is switched off, one typically gets back to energy-momentum consistent schemes that are addressed in the chapter authored by P. Betsch.

Due to the presence of finite rotations, the configuration space of multibody systems is typically nonlinear. In the chapter written by M. Arnold, A. Cardona, and O. Brüls, Lie group integrators are presented which preserve the Lie group structure of the underlying nonlinear configuration space by design.

An alternative route to the design of structure-preserving numerical methods are variational integrators. The newly emerging class of variational integrators is the topic of the chapter authored by A.J. Lew and P. Mata A. Last but not least the Chapter written by J. Gerstmayr, A. Humer, P. Gruber, and K. Nachbagauer provides insight into the absolute nodal coordinate formulation which is increasingly popular in the field of flexible multibody dynamics.

The combination of these chapters provides a unique perspective on up-to-date numerical methods for nonlinear structural dynamics and flexible multibody dynamics. Sincere thanks are due to the colleagues for preparing their chapters for this volume. Special thanks to Professors Martin Arnold, Alberto Cardona, Johannes Gerstmayr, Adrian Lew, and Ignacio Romero for taking part at the course and presenting their excellent lectures.

The course brought together nearly 40 participants from 8 countries. We are grateful to all participants for their interest and the numerous discussions that took place during and after the lectures. We are particularly thankful to the Scientific Council of CISM for supporting this course and recognizing the importance of the topic. We further thank the CISM staff for the excellent organization, support, and hospitality. Professor Paolo Serafini is gratefully acknowledged for his encouragement to publish these lecture notes and his patience to wait for the final versions.

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