Preface

The aim of this book is to give a self-contained introduction to the theory of infinite-dimensional systems theory and its applications to port-Hamiltonian systems.

The field of infinite-dimensional systems theory has become a well-established field within mathematics and systems theory. There are basically two approaches to infinite-dimensional linear systems theory: an abstract functional analytical approach and a PDE approach. There are excellent books dealing with infinite-dimensional linear systems theory, such as (in alphabetical order) Bensoussan, Da Prato, Delfour and Mitter [6], Curtain and Pritchard [9], Curtain and Zwart [10], Fattorini [17], Luo, Guo and Morgul [40], Lasiecka and Triggiani [34, 35], Lions [37], Lions and Magenes [38], Staffans [51], and Tucsnak and Weiss [54].

Many physical systems can be formulated using a Hamiltonian framework. This class contains ordinary as well as partial differential equations. Each system in this class has a Hamiltonian, generally given by the energy function. In the study of Hamiltonian systems it is usually assumed that the system does not interact with its environment. However, for the purpose of control and for the interconnection of two or more Hamiltonian systems it is essential to take this interaction with the environment into account. This led to the class of port-Hamiltonian systems, see [56, 57]. The Hamiltonian/energy has been used to control a port-Hamiltonian system, see e.g. [4, 7, 21, 43]. For port-Hamiltonian systems described by ordinary differential equations this approach is very successful, see the references mentioned above. Port-Hamiltonian systems described by partial differential equations is a subject of current research, see e.g. [14, 28, 33, 41].

In this book, we combine the abstract functional analytical approach with the more physical approach based on Hamiltonians. For a class of linear infinite-dimensional port-Hamiltonian systems we derive easily verifiable conditions for well-posedness and stability.

The material of this book has been developed over a series of years. Javier Villegas [58] studied in his PhD-thesis a port-Hamiltonian approach to distributed parameter systems. We are grateful to Javier Villegas that we could include his results into the book. The first setup of the book was written for a graduate course on control of distributed parameter systems for the Dutch Institute of Systems and Control (DISC) in the spring of 2009 which was attended by 25 PhD students. This

material was adapted for the CIMPA-UNESCO-Marrakech School on Control and Analysis for PDE in May 2009. In 2010-2011 we were the virtual lecturers of the 14th Internet Seminar on Infinite-dimensional Linear Systems Theory. More than 300 participants attended this virtual course and a wikipage was used to discuss the material and to post typos and comments. For this course we decided to add extra chapters on finite-dimensional systems theory, and to make the material in the later chapters more accessible.

We are indebted to the help from many colleagues and friends. We are grateful to the participants of the DISC-course, the CIMPA-UNESCO-Marrakesch School and the 14th Internet Seminar for their useful comments and questions. Large parts of the manuscript have been read by our colleagues Mikael Kurula (Twente) and Christian Wyss (Wuppertal), who made many useful comments for improvements.

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