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Advanced Topics in Control Systems Theory

Lecture Notes from FAP 2004

With 12 Figures

Springer

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To our lovely daughters,
AL & EP.

Preface

Advanced topics in control systems theory is a byproduct of the European school "Formation d'Automatique de Paris" (Paris Graduate School on Automatic Control) which took place in Paris through February and March 2004. The school benefited of the valuable participation of 17 European renowned control researchers and about 70 European PhD students. While the program consisted of the modules listed below, the contents of the present monograph collects selected notes provided by the lecturers and is by no means exhaustive.

Program of FAP 2004:

P1 Nonlinear control of electrical and electromechanical systems
A. Astolfi, R. Ortega

P2 Algebraic analysis of control systems defined by partial differential equations
J-F. Pommaret

P3 Nonlinear flatness-based control of complex electromechanical systems E. Delaleau

P4 Modeling and control of chemical and biotechnological processes
Jan van Impe, D. Dochain,

P5 Modeling and boundary control of infinite dimensional systems
B. Maschke, A.J. van der Schaft, H. Zwart

P6 Linear systems, algebraic theory of modules, structural properties
H. Bourles, M. Fliess

P7 Lyapunov-based control: state and output feedback
L. Praly, A. Astolfi, A. Loría

P8 Nonlinear control and mechanical systems
B. Bonnard

P9 Tools for analysis and control of time-varying systems
J. M. Coron, A. Loría

P10 Control of oscillating mechanical systems, synchronization and chaos
J. Levine, H. Nijmeijer

In particular, the lecture notes included in the subsequent chapters stem from modules P1, P2, P5, P6, P7 and P8. The material, which covers a wide range of topics from control theory, is organized in six chapters: two chapters on Lyapunov-like methods for control design and stability analysis, one chapter on nonlinear optimal control, one chapter on modeling of Hamiltonian infinite-ddimensional systems and two chapters on algebraic methods.

Each module listed above was taught over 21hrs within one week. Therefore, the contents of the present monograph may be used in support to either a one-term general advanced course on non linear control theory, thereby devoting a few lectures to each topic, or it may be used in support to more focused intensive courses at graduate level. The academic requirement for the class student or the reader in general is a basic knowledge on control theory (linear and non linear).

Advanced topics in control systems theory also constitutes an ideal start for researchers in control theory who wish to broaden their general culture or to get involved in fields different to their expertise, while avoiding a thorough book-keeping. Indeed, the monograph presents in a concise but pedagogical manner diverse aspects of modern control theory.

This book is the first of a series of yearly volumes, which shall prevail beyond the lectures taught in class during each FAP season. Further information on FAP, in particular, on the scientific program for the subsequent years is updated in due time on our URL `http://www.supelec.lss/cts/fap`.

FAP is organized within the context of the European teaching network "Control Training Site" sponsored by the European Community through the Marie Curie program. The editors of the present text greatefully acknowledge such sponsorship. We also take this oportunity to acknowledge the French national center for scientific research (C.N.R.S.) which provides us with a working environment and ressources probably unparalleled in the world.

Gif-sur-Yvette, France.
September 2004

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