

SIDRA Summer School, Bertinoro

Model Reduction by Moment Matching for Linear and Nonlinear Systems

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Aim: To give an introduction to the theory of model reduction, mainly exploiting the notion of moments, for linear and nonlinear systems.

While the linear theory of model reduction by moment matching can be developed, in its simplest form using very basic tools and ideas from linear systems theory, the nonlinear theory requires the introduction of several notions and concepts from nonlinear control theory and the theory of dynamical systems. All such notions, including the notions of invariant manifold, center manifold, steady state response, relative degree, zero dynamics, dissipativity, are introduced and discussed to make this a self-contained course.

Synopsis: The following topics will be covered, with the first three items presented in detail and items 4 and 5 with sketches of the main ideas/results.

1. Model reduction, examples and applications: VLSI circuits, structures, the International Space Station, image processing, the America’s Cup (with the aid of some slides).
2. Model reduction: abstract formulation of the problem.
3. A brief survey of model reduction methods.
4. Model reduction by moment matching: the notion of moment, families of reduced order models; matching with *structural* constraints; reducing reduced order models; moments at infinity, the frequency response of nonlinear systems; phasors. Examples.
5. Model reduction of systems with delays: linear and nonlinear systems, examples and extensions.
6. Model Reduction with Explicit Signal Generators: integral definitions of moments; reduced order models; the discontinuous phasor transform.

References: The course is based on the monographs “Nonlinear Model Reduction by Moment Matching”, G. Scarcioiti and A. Astolfi, Foundations and Trends in Systems and Control, Vol. 4, No. 3-4, 224-409, 2017. Additional recommended references are:

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