Πανεπιστήμιο Κύπρου
University of Cyprus

School of Engineering
Department of Electrical and Computer Engineering

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# Department of Electrical and Computer Engineering

Title: **«Structural identifiability of linear and of rational systems»**

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**Wednesday**, 27 January 2016, 17:00 – 18:00
Room XOD 02 – 013, New Campus - University of Cyprus

**Abstract:**
System identification is a subject area of control in which is investigated the problem: How to obtain from observations a control system with its parameter values?
A system identification procedure consists of the following steps: (1) With which system class to model the phenomenon of interest? (2) How to design an input trajectory for the plant so as to obtain an output trajectory which is useful for identification? (3) Which conditions imply that the parametrization of the selected system class is structurally identifiable? (4) How to determine an element of the parametrized system class from the input-output data obtained in Step (2)? (5) How to select the complexity of the system class using the available data?

In this lecture attention is focused on Step (3) of the above procedure, the structural identifiability. A parametrization of a class of systems is called structurally identifiable if the parameters of the selected parametrization can be uniquely determined from the input-output map of the system. A necessary and sufficient condition for structural identifiability is needed. Such a condition follows rather directly from the realization theory presented in an earlier lecture. A second problem is to characterize structural identifiability from the input-output trajectories rather than from the input-output map.

If a parametrization is not structurally identifiable then any optimization algorithm will in vain search through a subset of the parameter set containing all those parameter values having the same input-output map. An algorithm may then produce an arbitrary result. In practice, researchers in optimization working on a parameter estimation problem often encounter a nonlinear system which is not structurally identifiable. Therefore it is of interest to system identification to determine the structural identifiability before estimating parameter values. If it is not structurally identifiable then the parametrization is best changed.

The structural identifiability will be presented first for linear systems and then for rational systems. The conditions include controllability, observability, a canonical form condition, and a representation condition. The conditions will be illustrated by simple examples. For high-dimensional system one best uses a symbolic calculation package like Maple.

**Biography:**
Jan H. van Schuppen studied at the Department of Applied Physics of the Delft University of Technology and graduated with an engineering diploma in 1970. He was awarded a Ph.D. diploma by the Department of Electrical Engineering and Computer Science of the University of California at Berkeley, California, USA in 1973. He is currently employed as Full Professor at the Department of Mathematics of the Delft University of Technology, Delft, The Netherlands. His research area is control and system theory, and more widely applied mathematics. Research areas outside mathematics in which he has experience in include: motorway traffic, communication systems, compartmental modeling, and biochemical reaction systems. His current research focus is on: control of distributed systems and networks, control of hybrid systems, control of discrete-event systems, realization and system identification, and modeling and control of biochemical reaction systems.