MECHANICAL ENGINEERING SEMINAR

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Modeling and control of flexible structures via infinite-dimension transfer functions

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The first step in the design of a control system is modeling. Flexible structures are governed by partial differential equations and hence have an infinite dimension. However, most modeling methods use finite dimension approximations of the system, such as the truncated modal approach or the popular finite element method (FEM). While such models are practically and conceptually convenient, some important properties of the system's behavior are lost when using them.

A different approach was taken by the speaker and was presented in a series of publications, with his research students, over the last twenty years. It derives accurate, infinite-dimension, Laplace transfer functions for second order flexible structures. The building blocks of those transfer function are time delays, representing the wave motion, and low order rational expressions, representing the boundary phenomena. In physical terms the approach relates to traveling waves (the wave equation!) rather than standing waves as in modal theory. In addition to the valuable insights, the resulting models have several theoretical and practical advantages, such as accurate yet simple simulation schemes, exact frequency response for the entire frequency range, analytical solution for the finite time response and in particular handling damping in a natural way.

Perhaps the most notable advantage of the transfer function modeling approach is identification of the dedicated control law Absolute Vibration Suppression (AVS) which is a collocated rate feedback that completely eliminates the vibrations. In some cases, the suppression occurs in finite time. The closed loop transfer function becomes finite dimension plus the unavoidable delay.

The talk will go through the basic theory and several applications and extensions to it will be presented, including an alternative, Padé based, method for finite dimension approximation.

Seminars Coordinator: Prof. Sefi Givli