

COLLEGE OF ENGINEERING

# Control Seminar



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## Time-Delayed Control of Single-Input Single-Output Systems for Improved Stability Margins



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**ABSTRACT:** While time delays typically lead to poor control performance, and even instability, previous research shows that time delays can, in some cases, be beneficial. This talk presents a new benefit of time-delayed control for single-input single-output linear time invariant systems: it can be used to improve robustness. Time delays can be used to approximate state derivative feedback, which together with state feedback can reduce sensitivity and improve stability margins. Additional sensors are not required since the state derivatives are approximated using available measurements and time delays. A systematic design approach, based on solution of delay differential equations using the Lambert  $W$  method, is presented. The method is then applied to vibration control for a two-degree of freedom mechanical system. Simulation results demonstrate closed-loop performance identical to those obtainable with state feedback control but with improved stability margins.

**BIO:** A. Galip Ulsoy is the C. D. Mote, Jr. Distinguished University Professor Emeritus of Mechanical Engineering and the W.C. Ford Professor Emeritus of Manufacturing at the University of Michigan, Ann Arbor. He received the Ph.D. from University of California at Berkeley (1979), M.S. from Cornell University (1975), and B.S. from Swarthmore College (1973). His research interests are in dynamics and control of mechanical systems. He has received numerous awards, including the 2008 Rufus T. Oldenburger Medal and the 2013 Charles Russ Richards Award from ASME, the 2014 Hideo Hanafusa Award in Flexible Automation, the 2003 and 2016 Rudolf Kalman Best Paper Awards from the J. Dynamic Systems, Measurement and Control, is a member of the National Academy of Engineering, and is a Fellow of ASME, SME, IEEE and IFAC.