Power Systems Engineering Research Center

Input-Output Characteristics of the Power Transmission Network's Swing Dynamics: A Graph-Theory Perspective

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Description: New challenges are arising in analyzing and controlling transients in the bulk power transmission network. In particular, the growing penetration of intermittent renewables is increasing variability in the network's operating points and inertial characteristics, and hence in its swing dynamics. Meanwhile, new operational procedures (e.g. demand response) and stressors (e.g. cyber- attacks) are leading to an increasing diversity of disruptions, which require evaluation. At the same time, the wide deployment of synchrophasors and power-electronics holds promise to enable flexible wide-area feedback control of fast transients, provided that adequate control algorithms can be developed. Both the analysis of propagative disruptions, and the design of controls, essentially requires understanding input-output characteristics of the swing dynamics. In this talk, I will demonstrate that input-output properties of the swing dynamics, including the essential distinction between minimum-phase and non-minimum-phase dynamics, are closely tied to the network's topology and the location of the input and output relative to the topology. This analysis yields simple graph-theoretic insights into the input-output dynamics, which can then be used to support transient analysis under uncertainty, sensor and actuator placement, and model reduction.

Biography: Sandip Roy works as Professor and Associate Director for Research and Graduate Education in the School of Electrical Engineering and Computer Science at Washington State University. His research is primarily focused on developing techniques for the sparse control of dynamical networks, and using these techniques to support wide-area management of disruptions in large-scale infrastructure networks, including electric power and air transportation networks. Recently, he has also been interested in network analysis and design problems that arise in neurological and epidemiological processes. These research efforts have led to new models and algorithms, as well as software deployments, which are described in archival journal publications (about 60 in total) and conference articles (about 100 in total). His background is as follows: He received a B.S. in Electrical Engineering from the University of Illinois at Urbana Champaign in 1998, and Master's and PhD in Electrical Engineering from the Massachusetts Institute of Technology in 2000 and 2003, respectively.