Nonlinear Oscillations and the Steady-state Behavior of Nonlinear Feedback Systems

A long term goal in the theory of systems and control is to develop a systematic methodology for the design of feedback control schemes capable of shaping the response of complex dynamical systems, in both an equilibrium and a non-equilibrium setting.

In this talk, we will focus primarily on periodic steady-state behavior, a phenomenon that is pervasive in nature and in man-made systems. We review how a rotation in a magnetic field produces a stable nonlinear oscillation in a three dimensional, nonlinear model of an AC controlled rotor resulting in a constant steady-state angular velocity of the rotor. We present sufficient conditions for the existence of nonlinear oscillations. Moreover, using the recent solution of the Poincaré Conjecture, we show that these sufficient conditions are necessary for the existence of an *asymptotically stable* oscillation.

We conclude with a design of feedback laws for n-dimensional systems that allow the existence, periods and stability of periodic responses to be analyzed and shaped when the nonlinear feedback system is driven with an arbitrary periodic input.