Nonlinear Feedback Systems *

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Calendario: 16 ore, Martedì ore 10.30 - 12.30 e Giovedì ore 14.30 - 16.30. Prima lezione il 13 gennaio 2009. Aula DEI/G (Piano 3, Dipartimento di Ingegneria dell'Informazione, Via Gradenigo 6/a).

Prerequisiti: It is expected that students have taken courses in classical automatic control and linear systems. We will present basic material from nonlinear analysis and nonlinear dynamical systems, along with examples.

Tipologia di esame: The grade for the class will be based on homework.

Aim: Nonlinear feedback systems are pervasive in biology, control and communications. This course will teach methods for analyzing and designing nonlinear feedback systems. Particular applications will be to stability, stabilization and shaping the steady-state response of nonlinear control systems.

Topics:

1. Basic Nonlinear Analysis

   • The inverse function theorem, the implicit function theorem, the contraction mapping principle
   • One-dimensional nonlinear dynamical systems
   • Population dynamics with constant harvesting
   • The set-point control problem for nonlinear control systems

2. Basic Nonlinear Dynamics

   • Properties of solutions of nonlinear ordinary differential equations
   • The voltage controlled oscillator
   • The Poincaré map
   • Poincaré Bendixson Theorem

3. Stability of equilibria, periodic orbits and attractors

   • Limit sets for initial conditons and initial sets
   • Liapunov theory for invariant sets
   • The set-point control problem for a nonlinear AC motor
   • The existence and stability of periodic orbits
   • The steady-state behavior of nonlinear systems

4. Stability of control systems

   • Input-to-state systems
   • The small gain theorem for nonlinear systems

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- Zero dynamics and minimum phase systems
- Dissipative periodic processes

5. Shaping the response of a nonlinear control system

   - The steady-state response of a nonlinear control system
   - Output regulation
   - Analysis and design of the steady-state behavior of nonlinear feedback systems

References:

The course will be based on lecture notes and power point presentations that will be available on the course website. Other reference material would include:

H. Khalil, Nonlinear Systems, Prentice-Hall (for nonlinear dynamics)
A. Isidori, Nonlinear Control Systems, II, Springer-Verlag (for stability of control systems)