Non linear system

Finalità
The course provides concepts and some fundamental methods for the study of nonlinear dynamical continuous-time systems with special emphasis on stability theory. The presented analysis methods can be applied to a variety of physical and artificial phenomena. In the context of the automation science, some feedback systems will be analyzed also focusing on synthesis procedures for nonlinear control.

Programma
Introduction: Mathematical models and nonlinear phenomena. Examples. Existence and uniqueness of the solutions of state-space nonlinear models. The comparison lemma.
Second-order systems: Qualitative behavior of linear systems. Phase diagrams. Multiple equilibria. Limit cycles. Poincaré-Bendixson criterion.
Lyapunov stability theory: Autonomous systems. Lyapunov's theorem. La Salle's invariance principle. Linear systems and linearization. Regions of attraction. Nonautonomous systems and Lyapunov's theorems. Linear time-varying systems and linearization. Converse theorems. Boundedness of state motions.
Frequency domain analysis of feedback systems: The describing function method. Common nonlinearities. The extended Nyquist criterion and the orbital stability of limit cycles.
i>Nonlinear control: Stabilization methods with state feedback: feedback linearization, control Lyapunov functions, integrator backstepping. Regulation methods: integral regulators, dynamic inversion, feedforward/feedback schemes.

Attività d'esercitazione
Modeling examples of nonlinear systems (mechatronics systems,magnetic levitation, kinematic models of wheeled vehicles). Exercises of analysis and synthesis with the aid of MATLAB software.

Modalità d'esame
Written examination and subsequent oral examination. As an alternative to the oral exam the student can present a report on a short project.

Testi consigliati
Pdf slides of the lessons on the web site of the course.