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 elementary 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. Glimpse on bifuracations and chaos (higher-order systems).
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.
Nonlinear control: The stabilization problem. Linear state feedback. The control Lyapunov function approach. Integrator backstepping. Integral control for the regulation of nonlinear systems.

Modalità d'esame
Final written tests and oral exam.

Propedeuticità
Sistemi multivariabili.

Testi consigliati
Lecture notes.