Bilinear Control Systems: Theory and Applications **

Prof. Claudio Altafini[1]

[1] *SISSA (Int. School for Advanced Studies), Trieste*
Email: altafini@sissa.it

Calendario: 16 ore, Lunedì e Mercoledì ore 14.30 - 16.30. Prima lezione il 3 maggio 2010. Aula DEI/G (Piano 3, Dipartimento di Ingegneria dell'Informazione, Via Gradenigo 6/a).

Prerequisiti: Basic courses of automatic control and linear systems theory.

Tipologia di esame: The grading will be based on homeworks.

Aim: Bilinear Systems are an important class of nonlinear control systems. The course aims at giving an overview of the main control problems and of some of the mathematical tools (notably differential geometric and Lie algebraic methods) required in the study of bilinear control systems.

Topics:

1. Introductory material
   - manifolds, vector fields, tangent spaces;
   - orbits of vector fields and Frobenius Theorem;
   - controllablity and Chow Theorem;
   - drift versus driftless systems, accessibility versus controllability;
2. Bilinear control systems
   - bilinear systems and matrix transition Lie groups;
   - structure of matrix Lie groups (homogeneous spaces, transitivity, exponential map and canonical coordinates);
   - Lie algebras (Levi decomposition, semisimpicity, solvability, nilpotency, Cartan criteria);
   - controllability properties for bilinear control systems on matrix Lie groups;
3. Control methods
   - feedback linearization;
   - system inversion and differential flatness;
   - feedback stabilization;
4. Applications
   - rigid body motion (rigid bodies on SO(3) and SE(3); system on a sphere);
   - nonholonomic systems (trailer systems, chained form);
   - switching systems (simultaneous stability);
   - quantum control systems (Shrodinger equation, Liouville equation).

References: There is no book specific for the geometric aspect of bilinear control systems that will be treated in the course. Some parts can be found in
V. Jurdjevic. Geometric Control Theory, Cambridge Univ. Press. 1997.
Reading material will be provided during the course.

** Corso mutuato dalla *Scuola di Dottorato in "Ingegneria dell'Informazione"*