**网络与非线性系统控制研讨会**

**内容简介**

1. **程代展教授：Exploring Mathematical Foundation of Semi-tensor Product of Matrices Title:**

Motivated by semi-tensor product (STP) of matrices, a general algebraic and geometric structure of matrices is proposed. First, the identity equivalence is introduced to the set of matrices, which provides a partition for the set of matrices. Then the semi-tensor addition (STA) and STP, are introduced, which are the generalizations of matrix addition and matrix product respectively. Then the vector space structure is developed for each equivalent set of similar-shape matrices. Using the STA and STP, some further algebraic and/or geometric structures are developed, which include (i) the topological structure is given to the vector spaces, which makes it 2nd countable and Hausdorff; (ii) differential structure is posed, which makes it a dimension-varying manifold. The vector field, co-vector field, tensor-field etc. are constructed; (iii) for the equivalent class of square matrices, the dimension-varying Lie group and Lie algebra structures are proposed. Further properties of the Lie algebra are discussed.

1. **丘立教授：Thoughts in Control Education**

In this talk, we examine our effort in bringing optimal and robust control into undergraduate control education. Two topics will be presented:

1) Robust control for dummies;

2) Servo control for smarties.

In the first topic, we will see how system uncertainty can be modelled by a perturbation quartet so a rather easy robust control analysis and synthesis theory emerges. In the second topic, we will see how the optimal design problem of 2DOF tracking controllers can be formulated and solved using a polynomial approach.

1. **任伟教授：Distributed Average Tracking in Multi-agent Systems**

In this talk, we introduce a distributed average tracking problem and present distributed discontinuous control algorithms to solve the problem. The idea is that multiple agents track the average of multiple time-varying reference signals in a distributed manner based only on local communications with adjacent neighbors. We study the cases where the time-varying reference signals have bounded derivatives and accelerations. Tools from nonsmooth analysis are used to analyze the stability of the systems. Simulation examples are presented to show the validity of the theoretical results.

**4. 洪奕光教授：Distributed optimization design of multi-agent systems.**

In this talk, we introduce some of our recent results on distributed convex optimization design of continuous-time multi-agent systems. Here we study some fundamental problems of distributed optimization with various constraints. To study the problem, gradient-based algorithms are given to deal with the fundamental problems, and also extend our results to generalized cases including approximate gradients and the agents with nonlinear dynamics.

**5. 胡晓明教授： Intrinsic Formations of Reduced Attitudes**

In this talk, formation control for reduced attitudes is studied, in which both stationary and rotating ring and tetrahedron formations can be achieved and are asymptotically stable under a large family of gain functions in the control. Moreover, by further restriction on the control gain, almost global stability of the stationary formation is obtained. In addition, the control proposed is an intrinsic protocol that only uses relative information and does not need to contain any information of the desired formation beforehand. The constructed formation pattern is totally attributed to the geometric properties of the space and the designed inter-agent connection topology. Besides, a novel coordinates transformation is proposed to represent the relative reduced attitudes on the unit sphere , which is shown to be an efficient approach to reduced attitude formation problems.