

AA/ME/EE 597
Networked Dynamic Systems
Spring 2022; Syllabus

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Instructor's Office Hours: TBA
Class website: Canvas page and <https://shahriarta.github.io/teaching/>
Class Room: GUG 204
Class Time: M/W: 11:30 pm-12:50 pm

Textbook: *Graph Theoretic Methods in Multiagent Networks*, by M. Mesbahi and M. Egerstedt, Princeton, 2010.

Some reference books related to this course include:

Distributed Control of Robotic Networks, by F. Bullo, J. Cortes, and S. Martinez, Princeton, 2009.
Distributed Consensus in Multi-vehicle Cooperative Control, by W. Ren and R. Beard, Springer, 2008.

Some other reference books related to this course include:

Graph Theory, by R. Diestel, Springer, 2000.
Algebraic Graph Theory, by C. Godsil and G. Royle, Springer, 2001.
Networked Embedded Sensing and Control, edited by P. J. Antsaklis and P. Tabuada, Springer 2006.
Matrix Analysis, by R. A. Horn and C. R. Johnson, Cambridge, 1990.
Sync: The Emerging Science of Spontaneous Order, by S. Strogatz, Hyperion, 2003.

Handouts/papers: I will post papers/notes on the class website on topics of interest during the quarter; please check the website regularly.

Synopsis: A networked dynamic system is a set of dynamical units that interact over a signal exchange network for its coordinated operation and behavior. Such systems have found many applications in diverse areas of science and engineering, including multiple space, air, land, and underwater vehicles, energy and power systems, physiology, and medicine. Currently, there is an active research effort underway in control and systems community to formalize these dynamical systems and lay out a foundation for their analysis and control synthesis. This course provides an overview of graph-theoretic techniques that have proven instrumental for studying networked dynamic systems. Specifically, we will look at the following topics: (1) network models (graphs, random graphs, random geometric graphs, state-dependent graphs, switching networks), (2) network properties (some useful combinatorial and algebraic properties of graphs), (3) dynamics over networks- theory and some applications, including agreement/consensus protocol and its various extensions, and (4) distributed estimation. Other topics that will be covered- depending on the available time- include: advanced algebraic methods in graph theory, network controllability and observability, and games over networks. The prerequisite for the course is Linear Systems (AA/EE/ME 547).

Homework: We will have (approximately) biweekly homework assignments; please see the link on the class website. The contribution of homework toward the final grade is 70%.

Project: The project will consist of presenting a poster and submitting a report relevant to networked dynamic systems, related to your own research or a published journal paper by another researcher. The project will contribute 30% to the final grade. Some representative journals that you might like to start consulting for selecting your project topic are: *IEEE Transactions on Automatic Control*, *IEEE Transactions on Control Systems Technology*, *IEEE Transactions on Control of Network Systems* *AIAA Journal of Guidance, Control, and Dynamics*, *Automatica*, *European Journal of Control*, *SIAM Journal on Applied Dynamical Systems*, and *SIAM Journal on Control and Optimization*.