EE221A Linear System Theory
http://inst.eecs.berkeley.edu/∼ee221a/
Course Outline

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Lecture Information

Lectures: TuTh 9:30-11, remote instruction
Section: F 10-12, remote instruction

Contacts

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Prerequisites

Linear Algebra (Math 110 or equivalent)

Evaluation

There will be 10 problem sets, a midterm test, and a final exam. Course grades: Problem sets (40%); Midterm (20%); Final (40%).

Section

Discussion sections will be run by the GSI and will supplement the lecture by

- reinforcing concepts already seen in lecture

- discussing practice problems

- introducing applications for the theory seen in lecture.

Discussion handouts will be made available on the class website in advance of discussion, and we will assume that students have familiarized themselves with the material of the section. It would be helpful to start working on the problems before going to section.

If you cannot make the section, go through the handout and try working on the problems yourself. If you get stuck, check with your peers or with the GSI during OH.

Policies

It is encouraged that you work in groups, however each person must write up and hand in their own problem sets.

Course references

The course is based on a set of lecture notes which will be made available throughout the term.

Systems:

- F. Callier & C. A. Desoer, *Linear Systems*, Springer-Verlag, 1991.
- C.T. Chen, *Linear Systems Theory and Design*, Holt, Rinehart & Winston, 1999.
- T. Kailath, *Linear Systems Theory*, Prentice-Hall.
- R. Brockett, *Finite-dimensional Linear Systems*, Wiley.
- W. J. Rugh, *Linear System Theory*, Prentice-Hall, 1996.

Algebra:

- S. Axler, *Linear Algebra Done Right*, Springer, 1997.
- G. Golub and C. Van Loan, *Matrix Computations*, Johns Hopkins Press.
- M. Gantmacher, *Theory of Matrices, Vol 1 & 2*, Chelsea.
- G. Strang, *Linear Algebra and its Applications*, 3$^{\text{rd}}$ edition, 1988.

Analysis:

- J. Hale, *Ordinary Differential Equations*, Wiley.
- W. Rudin, *Principles of Mathematical Analysis*, Mcgraw-Hill.
- W. Rudin, *Real and Complex Analysis*, Mcgraw-Hill.

Course Outline

Linear Algebra: Fields, vector spaces, subspace, bases, dimension, range and null spaces, linear operators, norms, inner-products, adjoints.

Matrix Theory: Eigenspaces, the Jordan form, Hermitian forms, positive-definiteness, singular value decomposition, functions of matrices, spectral mapping theorem, computational aspects.

Optimization: Linear equations, least-squares approximation, linear programming.

Differential Equations: Linear time-varying systems $\dot{x} = A(t)x(t) + B(t)u(t)$ and the linear time-invariant case. Existence and uniqueness of solutions, Lipschitz continuity, linear ordinary differential equations, the notion of state, the state transition matrix.

Stability: Internal stability, input-output stability, the method of Lyapunov.

Linear Systems – Open-loop aspects: Controllability, observability, duality, canonical forms, the Kalman decomposition, realization theory, minimal realizations.

Linear Systems – Feedback aspects: Pole placement, stabilizability and detectability, observers, state estimation, the separation principle.

Linear Quadratic Optimal Control: Least-squares control and estimation, Riccati equations, properties of the LQ regulator.

Advanced topics as time permits: Robust control, hybrid systems.