LINEAR SYSTEMS THEORY
EE585
SPRING 2001

Edmond A. Jonckheere
University of Southern California
Department of Electrical Engineering–Systems
Los Angeles, CA 90089-2563
(213) 740-4457
jonckhee@eudoxus.usc.edu
http://eudoxus.usc.edu

Abstract

The purpose of this course is to provide the student with the basic tools of modern linear systems theory. We attempt to establish a balance between the application-oriented state-space methods, including controller design and numerical linear algebra, and the more algebraically-oriented polynomial methods, like the Smith-McMillan form and matrix fraction descriptions. This course is presented in such a way as to make it of interest to students in controls, communications and signal processing.

Instructor

Dr. E. Jonckheere
EEB 306
(213) 740-4457
jonckhee@eudoxus.usc.edu

Office hours: Mo., Wd. 10:00 a.m. - 12:00 noon
Grader
Khushboo Shah
EEB 321
(213) 740-4486
khushboo@usc.edu

Prerequisites

- EE301 (required); a good working knowledge of Fourier and Laplace transforms, transfer functions, poles/zeros, and partial fraction decompositions is required.
- EE441 (required); a good working knowledge of linear algebra (vector spaces, matrices) is required.
- EE482 (recommended); the basic knowledge of linear feedback systems is not required, but is desirable.

Formal textbook


Other recommended books


Format

one homework per week (20%)
one midterm (30%)
one final (50%)
General course description

Remark: Numerals correspond to chapters of the formal textbook, while letters are extra chapters, not available in formal textbook.


Chap. 2. Introduction to state-space versus transform methods in linear systems; simple network theory examples; simple mechanical system examples. Basic realization theory via elementary companion canonical forms.

Chap. 4. The convolution theorem, \( \exp(At) \), Cayley-Hamilton theorem, characteristic versus minimal polynomials, diagonalization of matrices, Jordan form. Introduction to polynomial matrix theory.

Chap. X. Matrix numerical analysis, singular values decomposition, and numerical computation of \( \exp(At) \) via Padé approximations.

Chap. Y. Systematic polynomial matrix theory via the Smith form; more systematic approach to Jordan form; the Belevitch-Rosenbrock matrix, and the multivariable zeros of a transfer matrix.

Chap. 5. Stability.

Chap. 6 Controllability, reachability, observability, reconstructibility in linear systems both from the state-space and the polynomial points of view.

Chap. 7 Canonical structure theorem. Geometric insight. Minimality of realization.

Chap. 8. Full-state feedback compensator design, observer design, pole placement methods; separation theorem and compensation by output feedback.

Chap. Z. Gramians, Lyapunov equation, Bartels-Stewart algorithm, Hankel matrix, introduction to balanced realization and related identification problems.
## Schedule

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chap. 1</td>
<td>Jan. 2001</td>
</tr>
<tr>
<td>Chap. 2</td>
<td>Jan. 2001</td>
</tr>
<tr>
<td>Chap. 4</td>
<td>Jan.-Feb. 2001</td>
</tr>
<tr>
<td>Chap X</td>
<td>Feb. 2001</td>
</tr>
<tr>
<td>Chap Y</td>
<td>Feb. 2001</td>
</tr>
<tr>
<td>Chap. 5</td>
<td>March 2001</td>
</tr>
<tr>
<td>Chap. 6</td>
<td>March 2001</td>
</tr>
<tr>
<td>Chap. 7</td>
<td>April 2001</td>
</tr>
<tr>
<td>Chap. 8</td>
<td>April 2001</td>
</tr>
<tr>
<td>Chap. Z</td>
<td>May 2001</td>
</tr>
</tbody>
</table>