Catalog Description: EE621: Nonlinear Control

Methods for analysis and design of nonlinear control systems emphasizing Lyapunov theory. Second order systems, phase plane descriptions of nonlinear phenomena, limit cycles, stability, direct and indirect method of Lyapunov, linearization, feedback linearization, Lyapunov-based design, and backstepping. Credit: 3.

Prerequisite: EE 478 Control Systems or equivalent.

Textbook:


Reference Books:


Instructor:

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Office Hours: Tuesday Wednesday 3:00pm-4:00pm, and by appointment
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Goals:

The course is designed to acquaint students with the techniques in the analysis and design of nonlinear control systems. In recent years, the availability of powerful low-cost microprocessors has spurred great advances in the theory and applications of nonlinear control. Many practical nonlinear control systems have been developed, ranging from digital “fly-by-wire” flight control systems for aircraft, to “drive-by-wire” automobiles, to advanced robotic and space systems. The subject of nonlinear control is occupying an increasingly important place in automation control engineering, autonomous mobile robotics, and has become a necessary part of the fundamental background of many engineering subjects.
Students will be able to use tools for the stability analysis of nonlinear systems, with emphasis on Lyapunov’s method. Nonlinear feedback control tools include linearization, feedback linearization, Lyapunov redesign, and backstepping. Case studies include the design of nonlinear control for mobile robotic systems (car-like robots, underwater vehicles) to achieve stabilization and asymptotic tracking of reference trajectories. The goal is to provide tools and methods that will enable students to analyze and control complex engineering systems.

Course Components:

Engineering: 80%
Science and Math: 20%

Schedule of Topics (tentative):

Week 1: Review of linear system theory, nonlinear models and nonlinear phenomena

Week 2: Second-order systems

Week 3: Fundamental properties of ordinary differential equations

Week 4: Lyapunov stability, Lyapunov direct and indirect methods

Week 5: Autonomous systems, the invariance principle, boundedness

Week 6: Nonautonomous systems, Barbalat’s lemma

Week 7: Mid-term exam

Week 8: Control design, linearization, stabilization via linearization, tracking

Week 9: Feedback linearization, input-output linearization, state feedback control

Week 10: Lyapunov redesign

Week 11: Backstepping

Week 12: In-class presentation #1

Week 13: In-class presentation #2

Week 14: Final project assignment
Topics and Textbook Chapters

<table>
<thead>
<tr>
<th>Topic</th>
<th>Textbook Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Nonlinear Control</td>
<td>1</td>
</tr>
<tr>
<td>Second-Order Systems</td>
<td>2</td>
</tr>
<tr>
<td>Fundamental Properties</td>
<td>3</td>
</tr>
<tr>
<td>Lyapunov Stability</td>
<td>4</td>
</tr>
<tr>
<td>Advanced Stability Analysis</td>
<td>8</td>
</tr>
<tr>
<td>Feedback Control</td>
<td>12</td>
</tr>
<tr>
<td>Feedback Linearization</td>
<td>13</td>
</tr>
<tr>
<td>Nonlinear Design Tools</td>
<td>14.1-14.3</td>
</tr>
</tbody>
</table>

Grading Policy:

Attendance 5%
In-Class Presentation 15%
Mid-Term Exam: 40%
Final Project: 40%

Homework will be assigned regularly and solutions will be posted online one week after the assignment. The mid-term exam will be closed-book and closed-notes, and it may be based on the homework.