E1 242 Jan 3:0

Nonlinear systems and control

Instructor

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Department: EE

Course Time: TTh 11:30-13:00

Lecture venue: EE

Detailed Course Page: http://www.ee.iisc.ac.in/people/faculty/pavant/2018j-E1-242.html

Announcements

Brief description of the course

This course is on the description, analysis and control of nonlinear systems. Nonlinear systems occur everywhere - in nature and in numerous engineering applications. So, it is very useful to a controls practitioner or theorist to have a good understanding of nonlinear systems and methods to design controllers for them. The focus of the course leans towards mathematical theory and analysis. However, interesting applications in various domains would also be discussed frequently.

Prerequisites

E1-241 "Dynamics of linear systems" or equivalent; Or background in linear algebra and ordinary differential equations; Or permission of the instructor. Familiarity with some simulation software such as MATLAB is useful.

Syllabus

- Equilibria and qualitative behavior

- Existence and uniqueness of solutions

- Lyapunov stability, invariance principle, converse theorems,

ultimate boundedness, input-to-state stability

- Input-output stability, small-gain theorem, passivity

- Feedback linearization, gain scheduling, sliding mode control,

backstepping

Selected topics from:

- Intro to switched and hybrid systems

- Applications in networked control such as control over channels with

quantization, sampling, time delays

- Applications in distributed systems and control such as consensus,

synchronization, coverage, etc.

Course outcomes

- The students would learn to use various basic and commonly used tools to analyze nonlinear systems and to design controllers for the same.

- The students would learn formal mathematical (theorem-proof style) analysis in the context of controls.

- The students would be exposed to the complexities of nonlinear systems as well as to applications in various domains.

Grading policy

- Project + Quizzes: 10%

- 2 Mid-term exams: 50%

- Final exam: 40%

Assignments

Homeworks contain a mix of formula based problems, problems that require critical thinking and systematic mathematical analysis/proofs and problems that explore interesting applications and open-ended problems.

Resources

1. H. K. Khalil. Nonlinear Systems. Prentice Hall, 3 edition, 2002.

2. S. S. Sastry. Nonlinear Systems: Analysis, Stability and Control. Number 10 in Interdisciplinary Applied Mathematics. Springer, 1999.
3. Mathukumalli Vidyasagar. Nonlinear systems analysis. Society for Industrial and Applied Mathematics, 2002.
4. E. D. Sontag. Mathematical Control Theory: Deterministic Finite Dimensional Systems, volume 6 of TAM. Springer, 2 edition, 1998