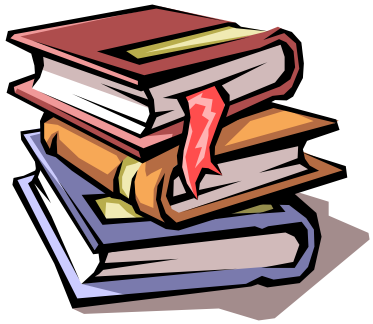
TTK4150 Nonlinear Control Systems



Syllabus/Reading list

The syllabus of the course is the material presented at the lectures and in the exercises. This is covered by the lecture handouts, the exercises and their solution manuals, and the literature below.

Text: Hassan K. Khalil, *Nonlinear Systems*, Global Edition, Pearson Education Limited, 2014.

Topics	Chapters	Comments
Important mathematical results used throughout the course	**Appendix A**	
Nonlinear phenomena	**Chapter 1**	
Fundamental properties	**Chapter 3:** Sections 3.1 and 3.4	
Phase plane analysis	**Chapter 2:** Sections 2.1 – 2.6	Bifurcations and chaos theory are not included in the syllabus.
Lyapunov stability	**Chapter 4:** Sections 4.1 – 4.5 Section 4.7: Theorem 4.15 Corollary 4.3 **Chapter 8:** Sections 8.2 – 8.3	• Theorem 4.3 is additional material. • Example 4.11 is additional material. • Pages 133 to 135 - end of example 4.12, are background material. • Example 8.10 after "c=1" is additional material. • Pages 325-329 starting with Theorem 8.5 are additional material.
Input-to-state stability	**Chapter 4:** Section 4.9	Background material is given in paper and talk by Sontag and mini-course by Loria.
Input-output stability	**Chapter 5:** Sections 5.1 and 5.4	Sections 5.2 and 5.3 are additional material. Example 5.14 is additional material
Stability of perturbed systems	**Chapter 9:** Sections 9.1 and 9.2	
Perturbation theory and averaging	**Chapter 10:** Sections 10.3 and 10.4	Background material is given in paper by Pål Liljebäck et. al.
Passivity	**Chapter 6:** Sections 6.1 – 6.2 Sections 6.4 – 6.5	Input-feedforward passivity and output-feedback passivity are additional material. Section 6.3 is additional material. Pages 254 – 259 including Example 6.12 are additional material.
Passivity-based control design	**Chapter 14:** Section 14.4	**Some material on passivity of linear systems (from Lozano et al.) is given in lecture handouts and assignments and is thus part of the syllabus.**
Input-output linearization	**Chapter 13:** Sections 13.1, 13.2 and 13.4	Example 13.16 – page 532 is additional material.
Backstepping	**Chapter 14:** Section 14.3	Pages 589 – 598 (until end of example 14.12).

Background material

ED Sontag: "The ISS Philosophy as a Unifying Framework for Stability-Like Behavior", in Nonlinear Control in the Year 2000, Vol 2. Eds. A. Isidori, F. Lamnabhi-Lagarrigue and W. Respondek, Springer Lecture Notes in Control and Information Sciences 258, 2001, pp. 443-468

ED Sontag: "The ISS Philosophy as a Unifying Framework for Stability-Like Behavior", Bode Talk (with narrative) at 2002 IEEE Conference on Decision and Control.

A Loria: "Cascaded nonlinear time-varying systems: analysis and design", Minicourse at the "Congreso Internaicional de Computation", Mexico, Nov. 14-16, 2001.

Lozano, Brogliato, & Egeland and Maschke: "Dissipative Systems Analysis and Control", Springer Verlag, Section 2.3

KJ Åström, RE Klein, and A Lennartsson: "Bicycle Dynamics and Control"

P. Liljebäck, K.Y. Pettersen, Ø. Stavdahl and J.T. Gravdahl, "Stability analysis of snake robot locomotion based on averaging theory", in Proc. IEEE Conference on Decision and Control, Atlanta, Georgia, December 15-17, 2010.

Additional material: This is course material that you will not get direct questions about at the exams, but which you should have read such that you know that it exists and where to find it in case you need it later.

Background material: This will neither be topics for direct questions at the exams, but is information that may provide valuable insight to really understand the core material of the course.