SF2832 - Mathematical systems theory
Plan for exercise sessions, autumn 2018

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This is not a static document - it may be updated through the course

The following is an outline of the exercise sessions, and also contains recommended exercises associated with each exercise session (selected by the teaching assistant).

In general, in the beginning of each exercise sessions there will be a recap of the theory part covered in the lectures. Then we will do some exercises on the board. Exercises in parenthesis is will be done if time permits.

Exercise session 0: Vector spaces and linear algebra recap.

The focus of this extra session is to recap some vector space theory and linear algebra needed in the course. In particular, it will focus on the concepts of range and kernel of a matrix, and how to compute these. We will also define a subspace and consider some fundamental relations between some of the subspaces related to a matrix.

Note: Some of this can be found in Beta, Chapter 4. A nice review can also be found among the supplementary material in the course: `https://www.math.kth.se/optsyst/grundutbildning/kurser/SF2832/Notes/LinAlg.pdf`. There is also plenty of other material available online, e.g., these slides: `http://ee263.stanford.edu/lectures/linalg.pdf`.

Exercise session 1: Linear dynamical systems and solving ODEs

In class: 1.4, 1.14, 1.5, (an exercise similar to 1.3)

Recommended: 1.1, 1.7 (Hint: consider the differential equation for Φ), 1.8, 1.10 and/or 1.11 and/or 1.12 and/or 1.13, 1.9, 1b on Homework 1 from 2016

Note: Chapter 9 in Beta might be useful help.

Exercise session 2: Reachability and observability

In class: 2.1, 2.3, an exercise related to Ex. 3.2.9, two exercises on observability, (2.6, 2.10)

Recommended: 2.4, 2.5, (2.11), 2.14

Exercise session 3: Stability and realization theory (standard reachable)

In class: 3.2, basic exercise on BIBO-stability, an exercise similar to 3.3 a, 4.6 a & b, (an exercise on time-varying systems, 3.6)

Recommended: 3.1, 3.3 b, 3.5 together with the extra question "Is the system stable?"

Exercise session 4: Realization theory (standard observable, McMillan degree, Kalman decomposition)

In class: 4.6 c - f, (example of Kalman decomposition)

Recommended: Foremost, a couple of the exercises 4.1-4.10.

Exercise session 5: Pole assignment and observers

In class: 5.1, 5.2, basic exercise on multiple input, (exercise on stabilizing non-reachable sys.)

Recommended: 5.4, 5.5, 5.7, 5.9, (5.12)

Exercise session 6: Linear quadratic control

In class: 6.1, infinite horizon version of 6.1, example of infinite horizon LQ control, 6.8

Recommended: 6.3, 6.5, 6.4, 6.6, (6.9), (6.11)

Exercise session 7: Kalman filtering

In class: Exam 2009-01-12 question 5, 7.2, exercise on Kalman filter with input = feedback using state estimates, (exercise on Kalman filter with deterministic input)

Recommended: 7.1, 7.7, (exercise given in class on Kalman filter with deterministic input)