Lineær algebra – 1
Introduction

Lineær algebra og dynamiske systemer

Troels B. Sørensen /Gilberto Berardinelli

Welcome

- **Two course lecturers**
  - **Troels B. Sørensen (first part), tbs@es.aau.dk**
  - **Gilberto Berardinelli (second part), gb@es.aau.dk**

- **Course information**
  - **Curricula https://moduler.aau.dk/course/2023-2024/ESNESDB4K2?lang=en-GB**
  - **Lecture information – reading, exercises, slides, .. on Moodle course page**

- **One lecture per week in February (update from S24)**
- **Two lectures per week in March**

Curricula

First part (Troels)

- (V) Matricer, underrum samt singulær værdier og egenværdier
- (V) Stabilitet af dynamiske systemer
- (V) LTI og input/output systemer
- (F) Skal have opnået en forståelse af linearisering af modeller beskrevet ved hjælp af differentialligninger …

(Gilberto) Second part

- (V) Z-transformation
- (V) Taylorrækker
- (F) Numerisk integration (f.eks. Runge-Kutta)
- … (F) samt kunne transformere disse til Laplace- og Z-domænet
- (F) Skal have indsigt i sammenhængen mellem modeller i kontinuert tid og de tilsvarende samplede modeller

- (F) Skal have indsigt i relevante egenskaber ved dynamiske systemer, såsom stabilitet, oversving, frekvensrespons, etc.
- (K) Skal kunne afgøre stabilitetsegenskaberne ved et LTI og input/output systemer, baseret på egenværdier og poler, samt system respons.
- (K) Skal kunne programmere og simulere dynamiske systemer

Literature

- **Books**
  - **"Advanced Engineering Mathematics", 10th ed., 2011 af Erwin Kreyszig, ISBN: 978-0-470-64613-7 (part 1)**
  - **"Discrete-Time Signal Processing", 2nd (Prenctice-Hall, Inc. 1999) or 3rd edition (Pearson 2014), A. V. Oppenheim and R. W. Schafer (part 2)**
  - **Older versions will do as well, but you need to ”translate” - topics are quite standard in engineering**

Course plan (curricula interpretation)

- **Linear Algebra (about 50% of the course)**
  - **Matrix basics, determinants, rank, linear independence, Gauss elimination**
  - **Linear systems of equations, vector spaces and basis vectors, linear transformations, some numerical considerations**
  - **Eigenvalue problems, vector bases, numerical methods**
  - **Taylor and MacLaurin series**
  - **Systems of differential equations, eigenvalue problems, stability**
  - **Systems of differential equations, linearization**

- **Discrete LTI systems (about 50% of the course)**
  - **Continuous to discrete domain (link to previous courses)**
    - **Linearity and time invariance, impulse response and convolution, stability and causality**
  - **The z-transform**
    - **Definition and region of convergence (ROC), right- and left-sided sequences, ROC analysis**
  - **Inverse z_transform**
    - **Defintion and inspection method, partial fraction expansion**
  - **Transform analysis**
    - **Linear constant coefficient difference equations, stability and causality, inverse systems**

Some prerequisites

- **Calculus (ESD1):**
  - **complex numbers, first and second-order differential equations and Laplace as a transform**
- **Kredsløbsteori (ESD1):**
  - **application of first and second order differential equations and Laplace (with interpretation of time-frequency relation)**
- **Instrumentering, interfacekredsløb og dynamiske systemer (ESD2):**
  - **fundamentals on feedback (stability), basic linear dynamic systems**

Course execution and work load

- The literature constitutes the course curricula – slides do not! but bring support (hopefully)
- Classical lectures in class, followed by …
  - Provides overview (hopefully), add supplementary information (a different view maybe), some examples
- Exercises in groups/individual
  - Important part of the curricula to apply theory and be confident with the topics
  - This is not (directly) exam preparation, but the skills needed
  - Advise to minimize the use of math programs
- Course load
  - A 5 ECTS course with expected 150 hours of effort (preparation for class, lecture in class, exercises in groups, follow up from lecture, preparation for the exam, exam attendance
- Comments and questions? Please consult us!

Course exam

- **A written three/four hour exam, start of June**
  - **The exam assignments will represent a subset of the course curricula – we sample!**
  - **Allowed use of literature in physical and/or electronic format, personal notes, math programs – but …**
  - **Online access to digital exam (only!)**

- **No ”type assignments”**
  - **But, application of learned skills**
  - **A typical exam exercise will combine different elements of what has been practized during exercise sessions**
  - **We will provide some example exercises during spring**

Exercises

- **Support where?**
  - **in B1-xxx?**
  - **Send an email?**
  - **?**
- **Solutions?**
  - **Will become available (to check) but we would like you to work ”from a blank sheet”, as preparation for the exam situation**