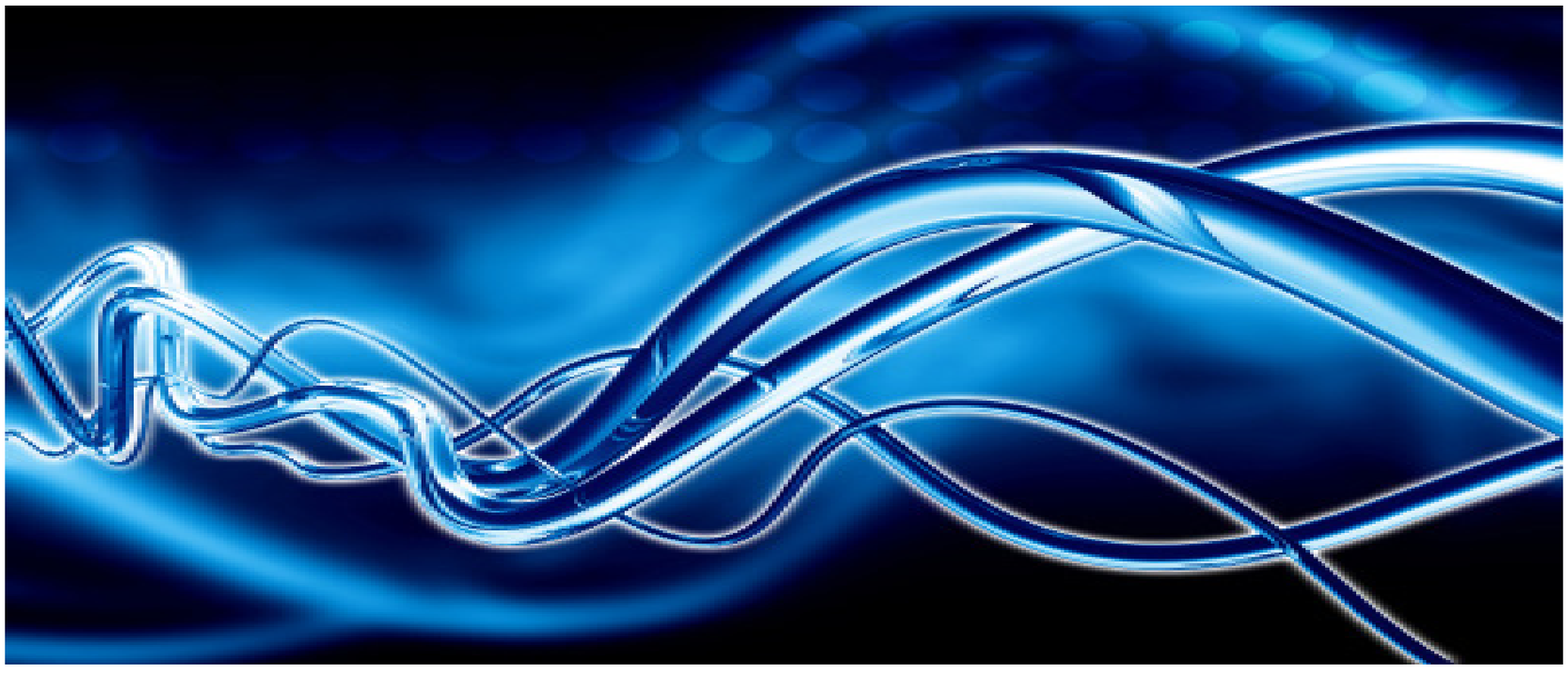
Signals and Systems



0. Introduction

Introduction

Welcome to the Signals and Systems course!

Course code: EE2S11

Lecturers:

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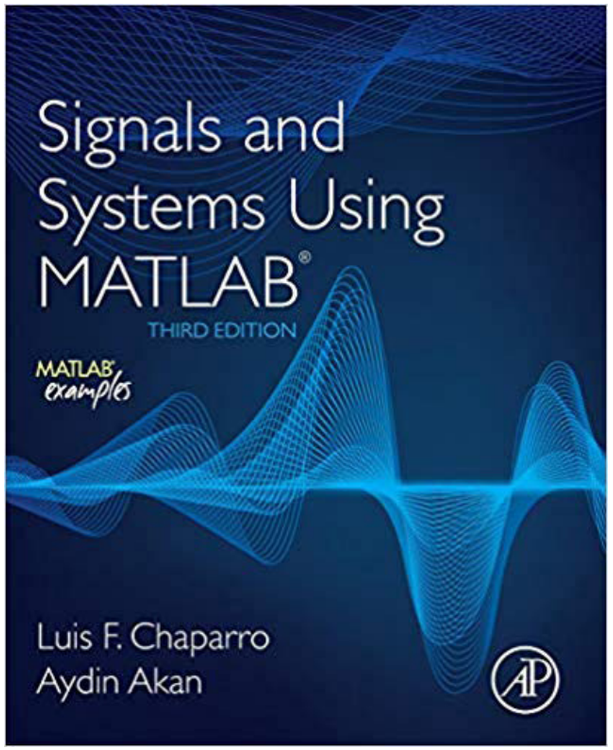
Introduction

- Book: Signals and Systems Using Matlab (3rd Edition)
  Authors: Luis F. Chaparro and Aydin Akan
  Publisher: Academic Press
  Available at the ETV and the library



Introduction

Lectures:

- Monday afternoon: 13:45 - 15:30
- Wednesday morning: 08:45 - 10:30
- *Friday morning: 08:45 - 10:30

Website: http://cas.tudelft.nl/Education/courses/ee2s11/

Contents:

- Indicated chapters and sections from the book (see slides and website)
- Slides (can be found on the website/Brightspace)

Introduction

Exam:

- Partial examination **1**, Wednesday **13-12-2023**
- Partial examination **2**, Thursday **30-01-2024**
- Final score is arithmetic average of partial examination scores

Please register for each partial examination on Osiris!

- Only a single resit exam (no partial examinations in this case)
- Resit is in Q5 (summer)

- Closed-book exam, but you are allowed to bring one A4 with handwritten notes

Contents

Introduction

Prerequisites

EE1M11/21/31 *Linear algebra and analysis*

EE1C11/21 *Lineair circuits*

EE1C11/21 *Complex function theory and differential equations*

Signals and Systems is a fundamental Electrical Engineering (EE) course

Course content is essential for basically every other course in EE

Introduction

Transformations play a crucial role in many applications

Examples of transforms:

The Fourier transform
The sine and cosine transform
The Laplace transform
The Hartley transform
The Z-transform
The Hilbert transform
The Radon transform
The Abel transform
The Hankel transform
The wavelet transform
The Mellin transform
...

Introduction

In this course we discuss three transforms with a wide range of applications in EE and beyond:

The Laplace transform (continuous-time)
The Fourier transform (continuous-time and discrete-time)
The Z transform (discrete-time)

Pierre Simon Laplace
Born 1749
Died 1827

Jean Baptiste Joseph Fourier
Born 1768
Died 1830

Introduction

A very important transform for discrete-time signals is the DFT

DFT = Discrete Fourier Transform

This transform can be applied in a very efficient manner

The resulting algorithm is called the FFT

FFT = Fast Fourier Transform

FFT = efficient version of the DFT

Introduction

The FFT:

"It has changed the face of science and engineering so much that it is not an exaggeration to say that *life as we know it would be very different without the FFT.*"

Charles Van Loan in *Computational Frameworks for the Fast Fourier Transform*

Frontiers in Applied Mathematics, SIAM, 1992

Introduction

Applications (just a selection):

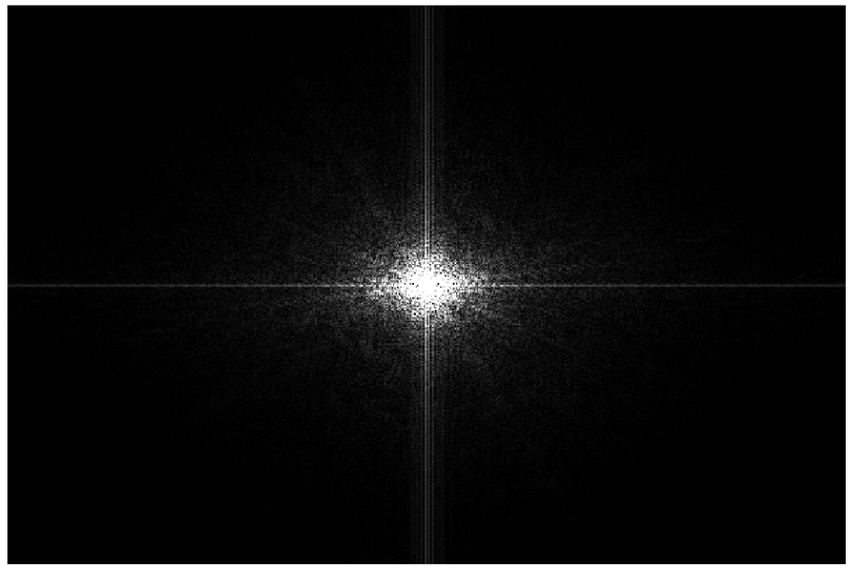
Circuit analysis
Filter design
Antennas
Radar signals and systems
Mechanical signals and systems
Biological signals and systems
Optical signals and systems
Astronomy
Image processing (a photo can be seen as a 2D signal)
...

Introduction - Image Processing

Image B - Aishwarya Rai

FT

Image B FFT2 Magnitude



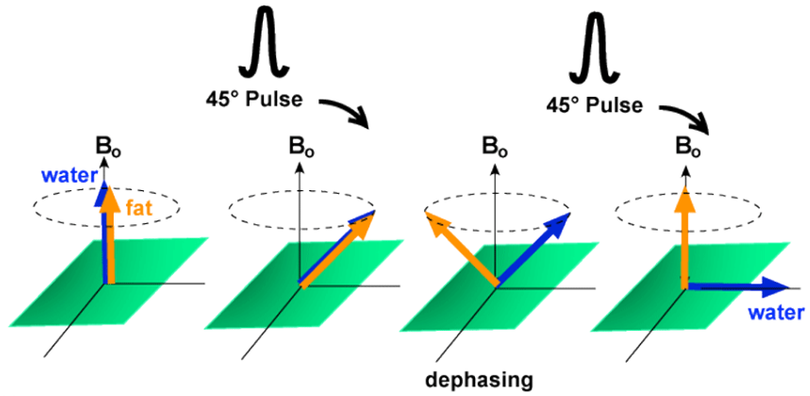
real image

Fourier image

Introduction - Magnetic Resonance Imaging (MRI)

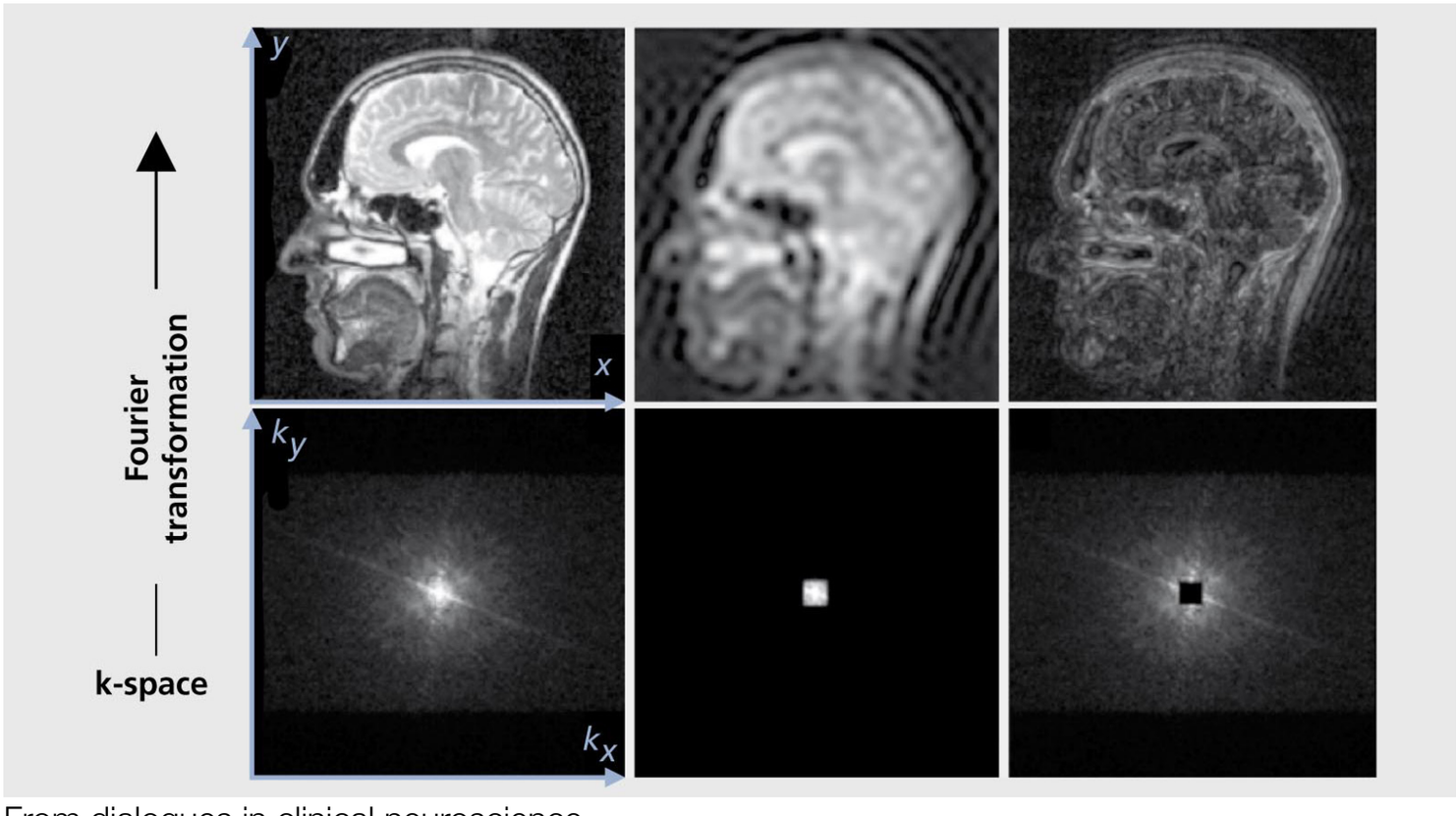
7T MRI Scanner at the Leiden University Medical Center

temporal FT



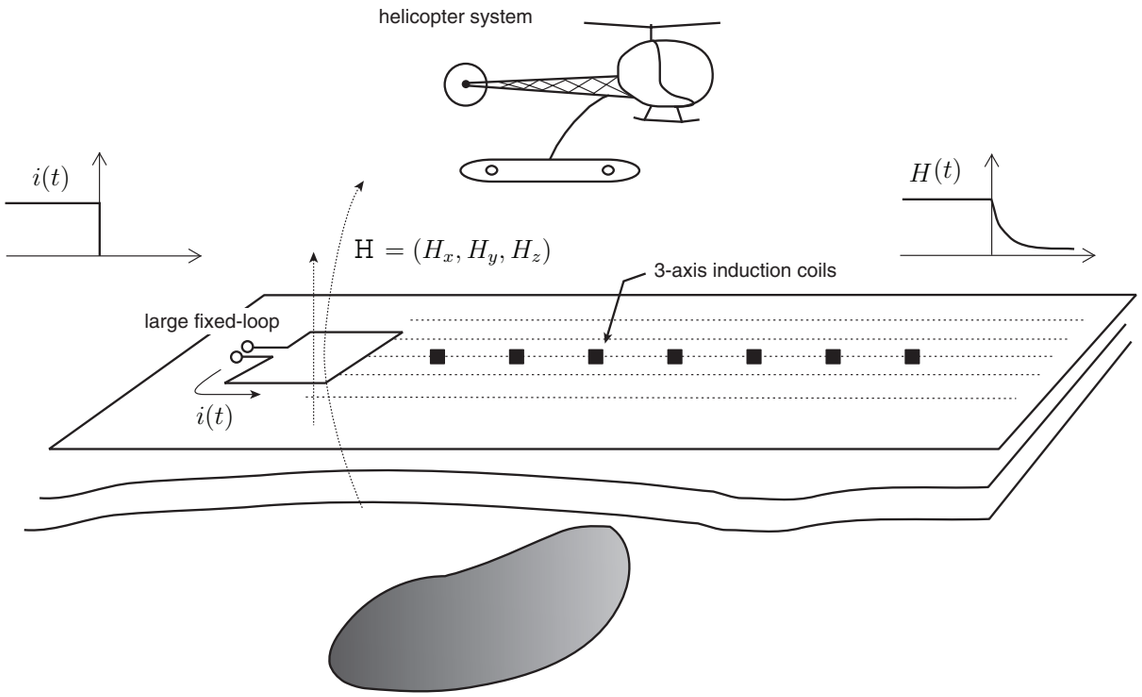
http://mri-q.com

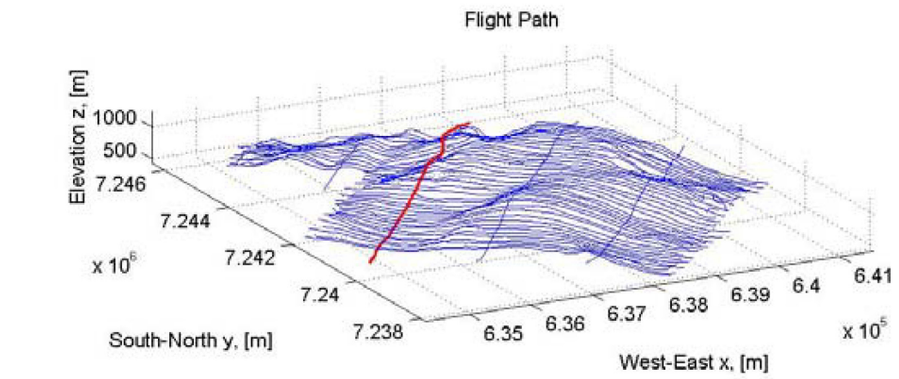
spatial FT

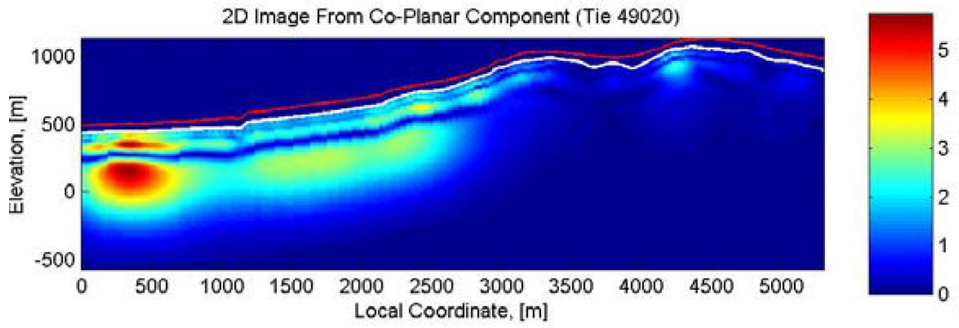


From dialogues in clinical neuroscience
http://www.dialogues-cns.org/

Introduction - imaging in geophysics







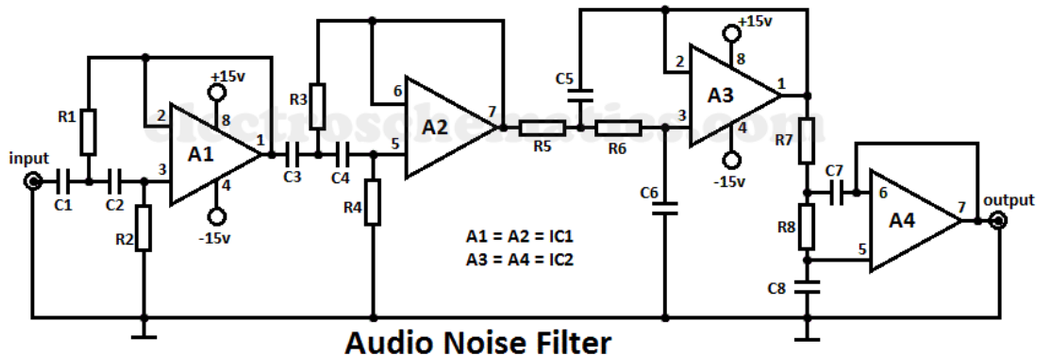
Introduction - Google's self-driving car

http://www.google.com

Virtually everything from this course is applied in Google's self-driving car project (signal processing, communications, control engineering, ...)

Introduction - other applications

Signal processing: design a filter that removes unwanted noise, low or high frequencies, or echos from a received signal



http://www.electroschematics.com

Communications: How to mount an audio/video or other data signal on some carrier that can easily be transmitted over great distances?