

# ESE 2+3 DSPESE and DSPESEL



## Course planning 2022-2023

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### 1 Goals

The aim of the course DSP for ESE is to familiarize students ESE with digital signal processing. Digital signal processing is a highly dynamic and useful field of application that can hardly be surpassed in the E / ESE domain. The focus of the course will be on the application of DSB in the ESE discipline.

After the course, students must be capable to:

- To name the general characteristics of digital signal processing.
- Describe the advantages and disadvantages of digital signal processing.
- Apply digital signal processing methods such as filters and transformations.
- DSB algorithms to implement in software / hardware.

## 2 Theoretical topics

The following issues are covered during the DSB theory lessons:

- Overview of Digital Signal Processing.
- The mathematical basis used in DSP.
- Matlab as a design tool.
- Software implementation techniques in C and C ++.
- Sampling process. Antialiasing and ADC. Different ADC structures.
- The Discrete Fourier Transform (DFT) and the fast Fourier Transform (FFT).
- The Z transformation.
- The FIR filter.
- The IIR filter.
- The Hybrid (Frequency Sampling) Filter.
- DSP Hardware - Microcontroller / DSP / FPGA.
- Introduction wxWidgets (for practicum)

## 3 Practical work topics

There are five practical assignments. These assignments are:

1. Create a template class with DSB methods (Console).
2. Implement two average-value calculations in a desktop PC application (wxWidgets).
3. Implement an FFT library in a desktop PC application (wxWidgets).
4. Create a FIR design program in a desktop PC application (wxWidgets).
5. Implement a FIR filter in a microcontroller (STMicroelectronics STM32).

## 4 Method

### 4.1 Theoretical part

The theoretical part will deal with the above mentioned content points, with the emphasis on practical applicability. In order to successfully complete the theoretical part, a pro-active attitude is indispensable. This means that the student must, in case of lack of clarity or difficulties, look for a solution. On the Internet ([Wikipedia](https://en.wikipedia.org/)) you can find a great wealth of information about this subject, which can be used as an addition to the offered teaching materials.

A remark about the usage of mathematics in this course: in general, complicated mathematical evidence is avoided as much as possible. It is impossible, however, to completely dispose of the subject of mathematics, because this reduces the material to 'craft level' and undermines the strength of the method. Adequate effort to master the mathematical basis is therefore essential.

### 4.2 Practice area

There are five practical assignments (see above). By participating in the practical you are introduced to the following issues:

- The ability to implement a formula or algorithm in C / C ++.

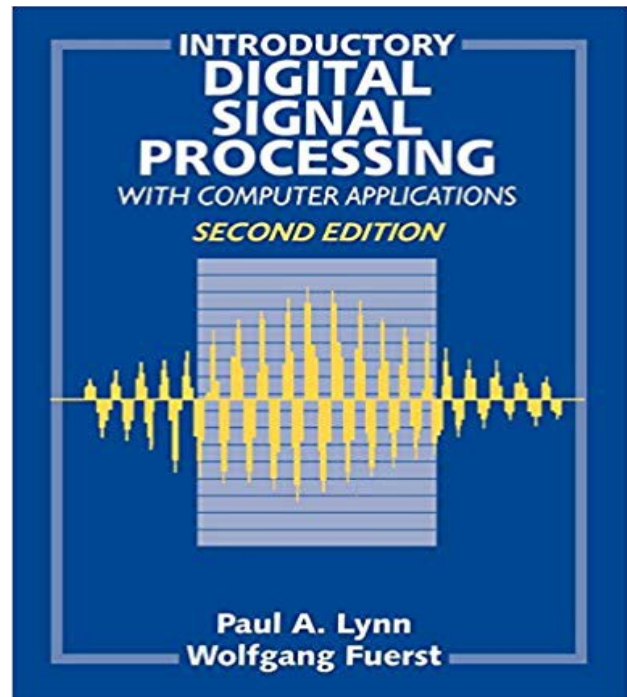
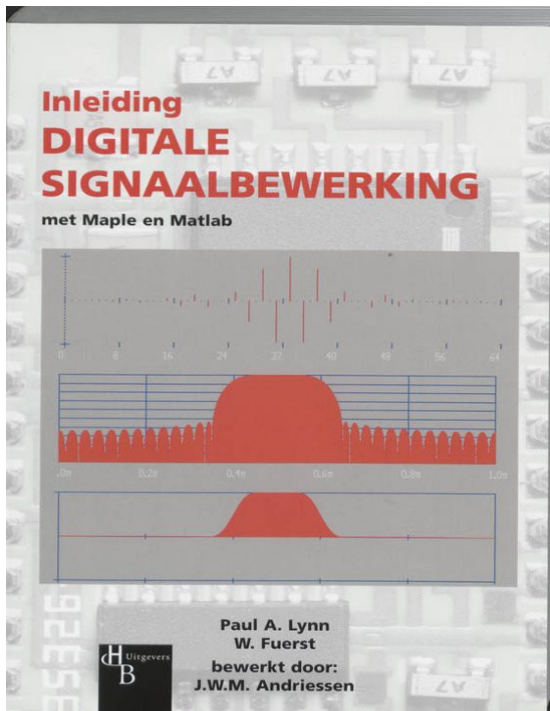
- Working with discrete and finite numbers that are based on measured values.
- A / D conversion and real-time processing.
- Introduction to the CMake, Visual Studio and CLion.
- Getting to know the wxWidgets GUI environment.
- Kennismaking met het gebruik van een externe bibliotheek.
- Ontwerp en implementatie van digitale filters.

## 5 Attributes

### 5.1 Theory book

The book used to support the theoretical part is one of these two copies:

1. "[Inleiding Digitale Signaalbewerking](#)" by Paul A. Lynn and Wolfgang Fürst, edited by W. Andriessen. ISBN 978-905-574448-0.
2. "[Introductory Digital Signal Processing](#)" by Paul A. Lynn and Wolfgang Fürst. ISBN 978-041-97631-8.



The books are almost identical, with the first book being in Dutch, the other book being in the English language.

It is strongly advised to purchase one of the two books. Without the possession of one of the two books, obtaining the course is almost impossible.

### 5.1.1 Covered chapters

In the aforementioned books, the following chapters and paragraphs will be used in the course:

Block 3 (DSPESE1) :

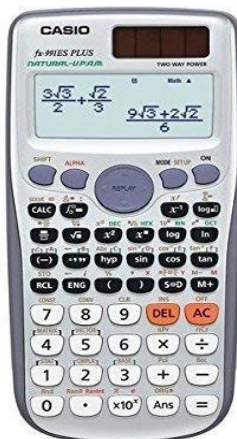
- Ch1
- Ch2 : §2.1 - §2.4 + first alinea of §2.5
- Ch3

Block 4 (DSPESE2) :

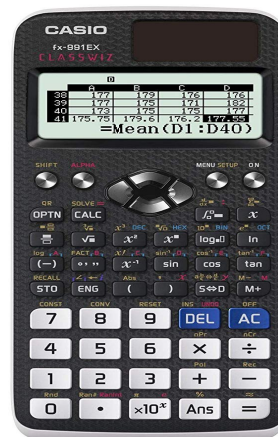
- Ch4 : §4.1 - §4.3
- Ch5 : §5.1 - §5.3.3 , §5.5
- Ch6 : §6.1 + §6.2
- [ES2 only] §6.4 + §6.5

### 5.2 Calculator

- A pocket calculator that is suitable for this course is recommended. Examples are: Casio FX115 / FX991-ES / EX Classwiz family: sale price around € 20-30.



Afbeelding 2: De Casio FX991ES



Afbeelding 1: De Casio FX991EX

Note that during the exams programmable calculators are not allowed. The above calculators are allowed, even though they are semi programmable.

These calculators offer more than your school calculator (the FX-82). The following properties are important in DSP:

- To display numbers naturally (see example above).
- To work with fractions.
- Work with complex numbers.
- Use polar numbers.
- 3rd / 4th degree equation to solve (also in the complex domain).
- Calculate series.

- Solve matrices and systems.

## 6 Time Table

<b>Week</b>	<b>Datum blok</b>	<b>Theory subjects</b>	<b>Book</b>	<b>Practical work</b>	<b>Remark</b>
				practical work enlistment. Acquaintance software development environment	
5	3,1 (1 Feb)	Introduction DSB.	H1		
6	3,2	Introduction DSB.	H1	Assignment 1	
7					holiday
8	3,3	Time domain analysis	H1	Assignment 1	
9	(4 Mrt)	Time domain analysis	H2	Assignment 1 or 2	
10	3,5	Frequency domain analysis	H2	Assignment 2	
11	3,6	Frequency domain analysis	H3	Assignment 2	
12	3,7	Frequency domain analysis	H3	Assignment 3	
13	3,8 (29 Mar)	Exam week	-	-	DSPESE I exam
14		Intermediate week		Assignment 3	
15	4,1 (12 Apr)	Z transformation	H4	Assignment 3	
16	4,2	Z transformation	H4	Assignment 4	
17	4,3 (3 May)	FIR filters	H5	Assignment 4	
18					holiday
19	4,4	FIR filters	H5	Assignment 4	
20	4,5	IIR Filters	H6	Assignment 4	
21	4,6	IIR Filters	H6	Assignment 5	
22	4,7 (31 May)	Embedded DSB in C/ C <sup>++</sup>	Extra doc.	Assignment 5	
23	4,8	Exam week			DSPESE II exam
24		Extra time			
25		Extra time			
26		-		Extra time	Final hand in date practical work: <b>23.06.2023 at 12u00 Zulu</b>

## 7 Course documentation and practical work

All documents for this course can be found on the [ESE server](#), under “[ir drs E.J Boks](#)”.

Dissemination of the documents is done via this website.

OnderwijsOnline is not or hardly used.

The practical assignments can be found on the [ESE SVN repository for the DSB practical work assignments](#). The assignments are carried out in room H036 of the HAN automotive building, Ruitenberglaan 31 in Arnhem. For more information, please refer to the practical work documentation which is available separately.

## 8 Contact information:

E.J Boks MSEE MA

When present at school : somewhere in the flex area .....

email: [ewout.boks@han.nl](mailto:ewout.boks@han.nl)