Course Package

Signals, Models & Systems - 1A

Name module	Signals, Models & Systems - 1A
Course Code	202000690
Educational programme	BSc Advanced Technology
Period	First quartile of the first semester (Quarter 1A)
Study load	15 ECTS
Coordinator	A.W. Schouwstra

Signals, Models & Systems			
Block 1A	Block 1B	Block 2A	Block 2B
Signals 202000627 (4 EC)			
Models 202000628 (4 EC)			
Project Signals, Models, and Systems 202000693 (3 EC)			
Electives (1 of the 4):			
Engineering Solid Mechanics - 202000695 (4 EC)			
Classical Mechanics - 202000694 (4 EC)			
Programming in Engineering - 202000630 (4 EC)			
Electronics - 202000644 (4 EC)			

<u>Required preliminary knowledge:</u> LaPlace Transform, Basic Mechanics, Electrical Network Analysis, Basic Matlab skills, Transfer Functions, Kirchhoff laws, Basic math skills (what is a matrix, derivative, integral, etc.), Complex numbers, Circuit Analyse Methods (and strong link with Models/Signals), Differential Equations, Module 4: Dynamical Systems, Elementary understanding of Statics and Materials Science.

202000627 - Signals

In this course, your will improve your understanding and ability to manipulate signals by studying their frequency content as obtained from Fourier Analysis. In the course, Continuous Fourier Transform and its properties is introduced, including convolution and modulation. With the use of Discrete Fourier Transform digital signals can be analyzed. Digital Filtering and the z-transform are introduced as an introduction to Digital Signal Processing with an emphasis on digital filtering.

202000628 - Models

In this course, you will learn more about the modeling of simple thermal systems. In addition, you will be introduced to modeling physical systems in general, and how to linearize non-linear systems.

After this introduction the three main topics of the modeling part are dealt with:

- a) Mixed systems combining components from different physical domains,
- b) Stability and Control of systems, and,
- c) Distributed systems.

These topics are accompanied by 4 practicals;

- 1. Characterization of an electro-motor (write measurement report),
- 2. The design of feedback for a motor-generator pair (same),
- 3. The non-uniform heating of a rod (full report),
- 4. The heat transfer in a flow experiment (oral exam).

202000693 - Project Signals, Models, and Systems

In the project, students have to demonstrate the ability to build and model a system of their choice. In addition, they will use signal analysis to characterize the performance or to control this system. So, in the project, you will apply all you learned in the courses Models and Signals.

The whole process of the project consists of three main steps:

- Week 1-3: Make a plan (attend the kick off, gather feedback from your teacher and peers). Go/no go
- Week 4-8: Build your system and make a video recordings of the process.
- Week 9-10, Finetune and demonstrate your system

The assessment of the project includes a report, a demonstration, a reflection on cooperation and a video of the project.

Electives (1 of the 4):

202000695 - Engineering Solid Mechanics

This course covers how the stiffness and strength of mechanical structures such as bars, shafts, and beams can be determined. The analysis of stiffness is required to determine how much a structure will deform. The analysis of strength is required to determine is a structure will collapse or fail. After the discussion of simple slender members, the theory will be extended to more general complex 3D loading situations. Based on this elasticity theory, it is explained how principle stresses can be used to establish practically useful failure criteria. The course takes your elementary understanding of statics and materials science to establish knowledge about the complex analysis of mechanical structures and machines.

202000694 - Classical Mechanics

We will study the motion of macroscopic particles and bodies using a new formulation of classical mechanics which is equivalent to Newtonian mechanics but offers several advantages when treating for instance constraints or different types of coordinate systems. We will derive Euler, Lagrange, and Hamilton formalisms and revisit the behavior of particles in a central force field, coupled oscillations, and normal mode analysis, as well as the dynamics of rigid bodies.

202000630 - Programming in Engineering

Computations are omnipresent in complex engineering problems in solid mechanics, fluid mechanics, civil and process engineering. Many problems are resolved with the aid of computers and dedicated programs today. Therefore, it is really important for an engineer to be familiar with computers and programming languages. In this course, you will learn how to translate problems into algorithms and

how to implement the algorithm into a computer language. We will focus on implementation in two widely used programming languages: MATLAB and C++. You will learn how to write, compile, and execute small programs in each language. We teach you how to write structured reusable code (object-oriented programming in C++) and how to visualize your solutions (in MATLAB). Further, we teach how to better understand, analyze, optimize, and debug code. The course consists of lectures as well as lots of practical exercises. The course is divided into two sections, C++ and MATLAB. At the end of each section, you will be asked to solve a final assignment (at home) and attend an oral exam. The course is complemented with an extension on the implementation on solving ODE's and the communication with an electronics platform as an Arduino and Raspberry Pi.

202000644 - Electronics

This electronics course starts with an introduction into modeling of non-linear components and an introduction into semiconductor physics of diodes, bipolar transistors. This is subsequently used for analysis and synthesis of basic analog circuits. These analog circuits are then extended into systems with feedback to create well-behaved stable circuits and well-behaved oscillators. The last part of the course presents an introduction into (radio frequency) transmitter systems, more complex analog circuits and digital electronics. The material is presented in the form of lectures/exercise classes and labs/projects. The final project of this module is the design, realization and characterization of an RF-transmit-receiver system to transmit audio wirelessly; this project is done in small groups, and includes peer review.