Digital signal processors and microcontrollers - course description

General information

Course name	Digital signal processors and microcontrollers
Course ID	06.5-WE-AutP-DSPandM-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Automatic Control and Robotics
Education profile	academic
Level of studies	First-cycle Erasmus programme
Beginning semester	winter term 2022/2023

Course information

Semester	5
ECTS credits to win	3
Course type	optional
Teaching language	english
Author of syllabus	• dr hab. inż. Krzysztof Sozański, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	15	1	-	-	Credit with grade
Laboratory	30	2	-	-	Credit with grade

Aim of the course

Basic knowledge of: programming digital signal processors (DSP) and microcontrollers; implementation of digital signal processing methods and digital control algorithms using DSPs and microcontrollers.

Prerequisites

Computer architecture, Foundations of digital and microprocessor engineering.

Scope

History, trends and comparison of digital signal controllers. Basic features of signal controllers. Differences between a DSP and microcontroller and microprocessor.

DSP architecture. Hardware multiplier, Harvard architecture, multibus architecture, pipeline, delayed braches, parallel operations, long accumulator, barrel shifter, circular buffer. Memory addressing modes: direct, indirect, immediate, circular, with bit reversion. Direct memory access systems (DMA). Multiprocessor systems.

Data types used in floating point and fixed point microprocessors. Fixed point and floating point arithmetics.

Fixed-point DSPs. Characteristics of DSP families: ADSP-21x and TMS320C2xx.

DSPs type VLIW (Very Long Instruction Word). Characteristics of DSPs - TMS320C6x.

Floating-point DSPs. Characteristics of floating-point families: ADSP-210xx and TMS320C67xx.

Instruction sets of DSPs - comparison. DSP programming tools. DSP programming with the application of C language. Programming environments: VisualDSP and Code Composer.

Implementation of basic structures of digital signal processing circuits using DSPs. Digital filters FIR and IIR, filter banks, DFT, interpolation and decimation, signal generators. Application of DSPs in video and audio signal processing.

DSP application in control systems. Specialized DSPs for power electronics control circuits: TMS320F24x, TMS320F28x, ADSP2199x.

Teaching methods

Lecture: conventional lecture.
Laboratory: laboratory exercises.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Is aware of the dynamic development of microprocessors, microcontrollers and signal processors.		• an evaluation test • an ongoing monitoring during classes	• Lecture • Laboratory
Knows processor construction and memory types, can analyze command lists.		• an evaluation test	• Lecture

Outcome description	Outcome symbols	Methods of verification	The class form
Can program in a low and high level language, carry out the analysis of a processor and is able to identify the operating status of a processor.		• an ongoing monitoring during classes	• Laboratory
Knows fundamentals of object programming and can design software, with the application of object paradigms.		• an ongoing monitoring during classes	• Lecture

Assignment conditions

Lecture: the main condition to get a pass are sufficient marks in written tests.

Laboratory: a condition of pass is to obtain positive grades from all laboratory exercises that are expected to be performed within the laboratory program.

Composition of the final grade: lecture: 60% + laboratory: 40%

Recommended reading

1. Martin K., *Digital Integrated Circuit Design (Oxford Series in Electrical and Computer Engineering)*, Oxford University Press, 1999.
2. Embree P.M., Kimble B., *C Language Algorithms for Digital Signal Processing*, Prentice Hall, 1991..
3. Sen M. Kuo and Woon-Seng S. Gan, *Digital Signal Processors: Architectures*, *Implementations, and Applications*, Prentice Hall, 2004.
4. Stallings W., *Computer Organization and Architecture*, Prentice Hall Inc., 2012.
5. Baer J., *Microprocessor Architecture: From Simple Pipelines to Chip Multiprocessors*, Cambridge University Press, 2009.
6. McFarland G., *Microprocessor Design (Professional Engineering)*, McGraw-Hill Professional, 2006.
7. Chassaing R., Reay D., *Digital signal processing and applications with the C6713 and C6416 DSK*, A John Wiley & Sons, Inc., 2008.

Further reading

1. Chassaing R., *Digital Signal Processing with C and the TMS320C30*, John Wiley & Sons, 1992.
2. K. Sozanski, Digital Signal Processing in Power Electronics Control Circuits, second edition, Springer, 2017.
3. P. S. R. Diniz, Adaptive Filtering Algorithms and Practical Implementation, Springer, 2020.
4. S. M. Kuo, B. H. Lee, W. T. Real-Time Digital Signal Processing: Fundamentals, Implementations and Applications, 3rd Edition, Wiley, 2013.

Notes

Modified by dr hab. inż. Krzysztof Sozański, prof. UZ (last modification: 21-04-2022 22:52)