COURSE DESCRIPTION CARD - SYLLABUS

Course name
Computer-aided measurements in industry

Course

Field of study
Electrical Engineering

Year/Semester
4/7

Area of study (specialization)
Electronics, measurements and lighting technology

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

6

Lecturers

Responsible for the course/lecturer:
Ph.D. Eng., Zbigniew Krawiecki

email: zbigniew.krawiecki@put.poznan.pl

Faculty of Control, Robotics and Electrical Engineering
Piotrowo 3A street, 90-965 Poznań

Responsible for the course/lecturer:
Ph.D. Eng., Piotr Kuwałek

email: piotr.kuwalek@put.poznan.pl

Faculty of Control, Robotics and Electrical Engineering
Piotrowo 3A street, 90-965 Poznań

Prerequisites

Basic knowledge in the scope of electrotechnics, electronics, computer science and metrology. Ability of the efficient self-education in the area concerned with a chosen field of studies. Awareness of the necessity of competence broadening and ability to show a readiness to work as a team.

Course objective

Expanding student's knowledge and and acquiring practical skills in the field of signal acquisition, digital signal processing, signal filtration, signal analysis in the time domain, frequency domain, and time-frequency domain. Acquiring the ability to implement signal processing algorithms in engineering applications.

Course-related learning outcomes

Knowledge

1. Student has knowledge of signal acquisition in measurement systems.
2. Student has knowledge of digital signal processing in measurement systems.
3. Student has knowledge of the application possibilities of modern measuring systems and their application in selected branches of industry.

Skills

1. Student is able to obtain information in the field of signal acquisition using digital measuring devices.
2. Student is able to set up and configure a measuring setup and apply appropriate tools for recording electrical signals in typical engineering tasks.
3. Student is able to use the generally available engineering tools for the analysis and processing of measurement signals.

Social competences

1. Student understands the need to improve professional competences in the field of computer technologies used in measurement systems.
2. Student understands that in the area of engineering tasks he should think and act in a creative and entrepreneurial manner..

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Laboratory: lecture exam grade (open, closed and problem questions, 50% pass mark). Bonus activity and quality of perception during the lecture.

Laboratory: evaluation of knowledge and evaluation of the implementation of measurement task, rewarding activity, assessment of the report made in class or at home. Continuous assessment, rewarding the increase of skills from building virtual instruments.

Programme content

Lecture: classification of measurement signals, analog to digital signal processing, construction of an analog-to-digital circuit, use of hardware and software resources in the measurement circuit. Functional structure of a virtual instrument for measuring electrical and non-electrical quantities in industry. Implementation of devices with the use of signal acquisition modules, discussion of the metrological properties of DAQ cards, comparison with traditional devices. General characteristics of selected environments for the control of measuring apparatus and signal processing. Preparation of the user interface and program code in the LabVIEW, Matlab, Python environment. Processing of measurement signals in the time and frequency domains, frequency analysis of stationary and non-stationary signals. Problems of measuring the fundamental frequency of real measurement signals. The problem of the occurrence of interferences and artifacts in measurement signals and methods of their minimization in the measurement process. Selected problems of signal filtration: statistical filters and filters with finite and infinite impulse response.

Laboratory: discussion of the laboratory regulations and OHS. Basics of programming in LabVIEW, execution of the user panel and graphic code. Development and execution of a measurement task for the acquisition of typical signals with the use of DAQ cards. Recording of supply voltage and currents of loads with the use of dedicated transducers, measurement card and application of a virtual instrument for signal acquisition. Registration of signals from sensors (converters of selected measurement values) in an environment susceptible to interference, recording of ECG/PPG signals. Introduction to Matlab/Python. Construction of statistical filters with a finite and infinite impulse response (work with synthetic data). Frequency analysis of measurement signals: DFT, STFT, CWT/DWT (work with synthetic data). Determining the fundamental frequency of the signal with the use of: autocorrelation function, DFT, Hilbert transform and zero crossing detection (work with synthetic data). Preparation of a script allowing for the improvement of the quality of measurement signal and determination of the basic parameters of signal - the use of Matlab/Python in the process of measurement signals analysis.

Teaching methods

Lecture with multimedia presentation supplemented by examples on the board, initiation of discussions in relation to the subject, presentation of a new topic preceded by a reminder of the previous lecture (main issues).

Laboratory: performing laboratory exercises independently or in small teams, discussion of many methods and aspects of problem solving (preparation of a measuring setup, performance of experiments, implementation of signal processing methods in the environment of a selected engineering support program, use of engineering tools of signal processing) with the help and supervision of the teacher .

Bibliography

Basic

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2. Świsulski D., Przykłady cyfrowego przetwarzania sygnałów w LabVIEW, Wydawnictwo Politechniki Gdańskiej, 2012.
3. Maj P., Wirtualne systemy kontrolno-pomiarowe, Wydawnictwo AGH, 2011.
4. Zieliński T.P., Cyfrowe przetwarzanie sygnałów - od teorii do zastosowań, Wydawnictwo Komunikacji i Łączności Sp. z o.o., Warszawa 2014.
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7. Kuwałek P., Estimation of Parameters Associated with Individual Sources of Voltage Fluctuations, IEEE Trans. on Power Delivery, vol. 36, no. 1, pp. 351-361, 2020.
8. Krawiecki Z., Odon A.: Wspomagane komputerowo stanowisko laboratoryjne do badania właściwości metrologicznych multimetrów na zakresach napieć przemiennych, Pomiary Automatyka Kontrola, 2007, vol. 53, nr 9 bis, s. 710-712.
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from photoplethysmographic signal, Biomedical Signal Processing and Control, vol. 66, art. no. 102483, 2021.

Additional

1. Rak R., Wirtualny przyrząd pomiarowy. Realne narzędzie współczesnej metrologii, Oficyna Wydawnicza Politechniki Warszawskiej, 2003.
2. Tłaczała W., Środowisko LabViewTM w eksperymencie wspomaganym komputerowo, Wydawnictwo WNT, 2014.
3. Madisetti V., The Digital Signal Processing Handbook, 2nd ed. Boca Raton, CRC Press, FL, USA 2009.
4. Charbit M., Digital Signal Processing (DSP) with Python Programming, Wiley-ISTE, 2017.
5. Downey A.B., Digital Signal Processing in Python, Green Tea Press, Needham, Massachusetts 2016.
6. Chruściel M., LabVIEW w praktyce, Wydawnictwo BTC, 2008.
7. Krawiecki Z, Szałkiewicz S., Hulewicz A., Identyfikacja artefaktów EKG zarejestrowanych podczas monitorowania sygnału EMG, Poznan University of Technology Academic Journals. Electrical Engineering - 2017, Issue 89, s. 229-238.
8. Kuwałek P., AM Modulation Signal Estimation Allowing Further Research on Sources of Voltage Fluctuations, IEEE Trans. on Industrial Electronics, vol. 67, no. 8, pp. 6937 6945, 2020.

Breakdown of average student's workload

	Hours	ECTS
Total workload	151	6,0
Classes requiring direct contact with the teacher	76	3,0
Student's own work (literature studies, preparation for project classes, project preparation) [1]	75	3,0

[1] delete or add other activities as appropriate