COURSE DESCRIPTION CARD - SYLLABUS

Course name
Advanced metering infrastructure in power grids [S2Eltech2-ISP>RSPwSE]

Course

Field of study
Electrical Engineering

Year/Semester
2/3

Area of study (specialization)
Smart Measurement Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of electrical engineering, metrology and signal theory. Basic information on electronics. Ability to effectively self-study in a field related to the subject. Awarness of the need to expand their competences and is ready to cooperate as part of a team.

Course objective

Understanding selected problems in the field of advanced metering infrastructure, including smart energy meters. Understanding selected current problems of assessing the power quality in power grids.

Course-related learning outcomes

Knowledge:
1. Ability to determine the areas of application and scope of applications for modern distributed measurement systems.
2. Ability to explain the principles and techniques of acquisition and processing of measurement signals

for the needs of modern industrial applications in power grids.

Skills:
Ability to creatively design modern measurement systems, using the possibilities offered by modern technologies, considering the limitations of the current level of knowledge and technology.

Social competences:
1. Ability to think and act in an entrepreneurial manner in the field of modern distributed measurement systems.
2. Understanding the need for wider dissemination of knowledge in the field of simple and complex measurement systems used in power grids.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture
Evaluation of the knowledge with a written exam related to the content of lectures (test, computational and problem questions). Passing threshold of test equals 50%. The grade from project as well as attendance and activities during the lectures are taken into account.
Project
Assessment of knowledge necessary to implement the problems posed in the area of project tasks. Assessment of skills related to the implementation of the measurement task. Evaluation of the prepared project.

Programme content

Lecture
L1: Legal and normative requirements for measurements in power grids.
L2: Selected problems related to the power quality evaluation.
L3: The structure of distributed systems. Problems in this type of systems. Components of distributed systems.
L4: Characteristics of distributed systems in modern power grids.
L5: AMI smart energy meters as components of distributed metering systems. Measurement capabilities of AMI smart energy meters.
L6: Selected problems of diagnosis of disturbances in power grids based on distributed measurement systems.
L7: Problems of processing and analyzing data obtained from distributed measurement systems.
Project
P1: OHS, introduction and presentation of requirements.
P2: Measurement of quantities that are directly measured by smart energy meters. Oscilloscope measurements of supply voltages in low voltage network. Non-invasive measurements of currents in power grids. [Demonstration laboratory classes]
P3: Introduction to AMI smart energy meters and the software for remote communication with these meters.
P4: Quasi-simultaneous recording of instantaneous values of voltages and currents with the use of transducers and selected quantities recorded with the use of AMI smart energy meters (active power, reactive power, voltage parameters: rms value, fundamental frequency, THD).
P5-P7: Preparation of application (script or calculation sheet) that allow for determination: active power, reactive power using different definitions (at least two: Budeanu def and Frieze def), RMS value, fundamental frequency, higher harmonics determined by the subgrouping method and THD.
The final report should include:
- reports from introductory classes [P1-P4];
- definitions of measured quantities under the project tasks [P4], normative guidelines for the measurements of selected measured quantities and a list of permissible deviations of measured quantities in the power grid, which are defined in the current normative requirements and in the current legal requirements;
- description of the prepared application (script or calculation sheet);
- comparative analysis of the results obtained by the prepared application and the results obtained from AMI smart energymeters;
- evaluation of the power quality in the laboratory network.

Course topics

none

Teaching methods

Lecture
Lectures are performed using multimedia presentations illustrated with simulation examples and necessary mathematical calculations on the blackboard. Theoretical questions are presented in the exact reference to the practice.
Project
Working in teams and perform project tasks.
The teaching methods used are student-oriented and motivate them to actively participate in the teaching process through discussions and papers.

Bibliography

Basic:
1. Standards for distributed systems, incl. in the field of AMI energy meters and communication protocols (e.g., EN 50470, EN 62056-4-7, EN 62056-5-3, EN 62056-6-1, EN 62056-6-2).
2. Electromagnetic Compatibility Standards: PN-EN 50160, PN-EN 61000-4-30, PN-EN 61000-4-15, PN-EN 61000-4-7.
3. Rozporządzenie Ministra Gospodarki z 4 maja 2007 r. w sprawie szczegółowych warunków funkcjonowania systemu elektroenergetycznego. (Dz.U. Nr 93, poz. 623, z dnia 29 maja 2007 r.).
4. Z. Kowalski, Jakość energii elektrycznej , Wyd. PŁ, Łódź, 2007.
5. J. Szabatin, Podstawy teorii sygnałów, WKiŁ, Warszawa 2003.
6. G. Wiczyński, Badanie wahań napięcia w sieciach elektrycznych, Wyd. PP, Poznań, 2010.
7. Z. Hanzelka, Jakość dostawy energii elektrycznej. Zaburzenia wartości skutecznej napięcia, Wyd. AGH, Kraków, 2013.

Additional:
8. D. Zmarzły, Badania jakości energii w wybranej farmie wiatrowej, Wyd. PO, Opole, 2014.
9. T. Sikorski, Monitoring i ocena jakości energii w sieciach elektroenergetycznych z udziałem generacji rozproszonej, Wyd. PWr, Wrocław, 2013.
10. T. Tarasiuk, Ocena jakości energii elektrycznej w okrętowych systemach elektroenergetycznych z wykorzystaniem procesorów sygnałowych, Wyd. Akademii Morskiej, Gdynia, 2009.
11. P. Ruszel, Kompatybilność elektromagnetyczna elektronicznych urządzeń pomiarowych, Wyd. PWr, Wrocław, 2008.
12. K.L. Kaiser, Electromagnetic compatibility handbook, CRC Press, 2005.
13. A. Bień, Metrologia jakości energii elektrycznej w obszarze niskoczęstotliwościowych zaburzeń napięcia sieci, Wyd. AGH, Kraków, 2003.
14. R. Schaumann, Van Valkenburg, E. Mac, Design of analog filters, Oxford University Press, 2001.
15. www.electropedia.org
16. Wiczyński G., Kuwałek P., Voltage Distortion Influence on Flicker Severity Measurement by AMI Energy Meters, IEEE Transactions on Industrial Electronics, vol. 69, no. 10, pp. 10684-10693, 2022.
17. Wiczyński G., Kuwałek P., Influence of Sampling Rate on Flicker Assessment by IEC Flickermeter Built-in AMI Energy Meters, IEEE Transactions on Industrial Electronics, vol. 69, no. 9, pp. 9566-9574, 2022.
18. Kuwałek P., Wiczyński G., Problem of Total Harmonic Distortion Measurement Performed by Smart Energy Meters, Measurement Science Review, vol. 22, no. 1, pp. 1-10, 2022.

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,00
Classes requiring direct contact with the teacher	32	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	28	1,00