



## Subject card

|                                             |                                                                                                                                                                                                                                                                                         |                                                          |                                         |                                     |                                                                                              |            |     |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------|------------|-----|
| Subject name and code                       | Basics of chemical metrology, PG_00060882                                                                                                                                                                                                                                               |                                                          |                                         |                                     |                                                                                              |            |     |
| Field of study                              | Podstawy metrologii chemicznej                                                                                                                                                                                                                                                          |                                                          |                                         |                                     |                                                                                              |            |     |
| Date of commencement of studies             | October 2023                                                                                                                                                                                                                                                                            |                                                          | Academic year of realisation of subject |                                     | 2025/2026                                                                                    |            |     |
| Education level                             | first-cycle studies                                                                                                                                                                                                                                                                     |                                                          | Subject group                           |                                     | Optional subject group<br>Subject group related to scientific research in the field of study |            |     |
| Mode of study                               | Full-time studies                                                                                                                                                                                                                                                                       |                                                          | Mode of delivery                        |                                     | at the university                                                                            |            |     |
| Year of study                               | 3                                                                                                                                                                                                                                                                                       |                                                          | Language of instruction                 |                                     | Polish                                                                                       |            |     |
| Semester of study                           | 5                                                                                                                                                                                                                                                                                       |                                                          | ECTS credits                            |                                     | 3.0                                                                                          |            |     |
| Learning profile                            | general academic profile                                                                                                                                                                                                                                                                |                                                          | Assessment form                         |                                     | assessment                                                                                   |            |     |
| Conducting unit                             | Department of Analytical Chemistry -> Faculty of Chemistry -> Wydziały Politechniki Gdańskie                                                                                                                                                                                            |                                                          |                                         |                                     |                                                                                              |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                                                                                      |                                                          | prof. dr hab. inż. Piotr Konieczka      |                                     |                                                                                              |            |     |
|                                             | Teachers                                                                                                                                                                                                                                                                                |                                                          | prof. dr hab. inż. Piotr Konieczka      |                                     |                                                                                              |            |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                                                                                             | Lecture                                                  | Tutorial                                | Laboratory                          | Project                                                                                      | Seminar    | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                   | 15.0                                                     | 0.0                                     | 15.0                                | 0.0                                                                                          | 0.0        | 30  |
|                                             | E-learning hours included: 0.0                                                                                                                                                                                                                                                          |                                                          |                                         |                                     |                                                                                              |            |     |
|                                             | eNauczanie source address: <a href="https://enauczanie.pg.edu.pl/2025/user/index.php?id=2434">https://enauczanie.pg.edu.pl/2025/user/index.php?id=2434</a>                                                                                                                              |                                                          |                                         |                                     |                                                                                              |            |     |
| Learning activity and number of study hours | Learning activity                                                                                                                                                                                                                                                                       | Participation in didactic classes included in study plan |                                         | Participation in consultation hours |                                                                                              | Self-study | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                   | 30                                                       |                                         | 5.0                                 |                                                                                              | 40.0       | 75  |
| Subject objectives                          | Learning about useful mathematical statistics, methods of processing measurement results, familiarisation with the problem of estimating measurement uncertainty including creating an uncertainty budget, characteristics of the analytical method, determining validation parameters. |                                                          |                                         |                                     |                                                                                              |            |     |

| Learning outcomes               | Course outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Subject outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Method of verification                                                                                                  |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
|                                 | [K6_K02] understands the non-technical aspects and implications of the activities of a chemical engineer, including the impact on the environment, is aware of professional behaviour, observance of professional ethics and respect for diversity of views and cultures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | The student understands the importance of adhering to professional ethics in the work of a chemical engineer, including responsibility for the safety of people and the environment. They are aware of the need to behave professionally, including reliable communication of research and analysis results, an honest approach to work and respect for legal regulations. They understand that the actions of a chemical engineer have social and economic consequences, and are therefore able to consider them in the context of sustainable development. | [SK3] Ocena umiejętności organizacji pracy<br>[SK5] Ocena umiejętności rozwiązywania problemów występujących w praktyce |
|                                 | [K6_W02] has knowledge of inorganic, organic, physical and analytical chemistry useful for obtaining selected groups of compounds, determining their physical and chemical properties allowing for their quantitative and qualitative analysis, making measurements and determining the parameters of chemical reactions, phenomena and processes occurring in chemical technology                                                                                                                                                                                                                                                                                                                                                                                                                        | The student knows the basic laws and concepts of inorganic, organic, physical and analytical chemistry and their applications in chemical technology. The student has knowledge of methods for obtaining selected groups of chemical compounds and their physical and chemical properties. The student understands the mechanisms of chemical reactions and is able to determine the kinetic and thermodynamic parameters of processes.                                                                                                                      | [SW3] Ocena wiedzy zawartej w opracowaniu tekstowym i projektowym                                                       |
|                                 | [K6_U05] recognises and identifies the relationship between technological issues, implemented in industrial practice, and their impact on various elements of the environment, in the context of mechanisms and conditions of sustainable development, recognizes their systemic and non-technical aspects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | The student is able to analyse and assess the environmental impact of selected industrial processes, taking into account technical and non-technical (economic, social, cultural) factors. The student is able to identify systemic links between technology, the environment and sustainable development policy, and propose solutions that minimise negative impacts.                                                                                                                                                                                      | [SU1] Ocena realizacji zadania<br>[SU3] Ocena umiejętności wykorzystania wiedzy uzyskanej w ramach przedmiotu           |
| Subject contents                | Course content – lecture<br>Fundamentals of mathematical statistics; statistical parameters and basic statistical tests; creating an uncertainty budget and estimating measurement uncertainty; validation parameters methods of <u>determination, calculation and verification</u> . The course will be completed with a final examination.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                         |
|                                 | Course content – laboratory<br><u>Calculations using Excel spreadsheets related to the practical implementation of the lecture topics.</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                         |
| Prerequisites and co-requisites | Students should have basic knowledge of general and analytical chemistry (concepts of solution concentration, chemical reactions, basic techniques of quantitative and qualitative analysis). Know the basics of mathematics and statistics (operations on real and exponential numbers, basic statistical concepts).<br>Be able to read and interpret numerical data and graphs.<br><br>In addition, they should have completed courses in physical chemistry or instrumental analysis, which will help them understand concepts related to accuracy, sensitivity and calibration of measuring equipment. They should be able to use data analysis software, such as Excel or Origin, or have a basic knowledge of programming (e.g. Python, R) especially for statistical analysis of measurement data. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                         |
| Assessment methods and criteria | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Passing threshold                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Percentage of the final grade                                                                                           |
|                                 | seminar                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.0%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 50.0%                                                                                                                   |
|                                 | lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.0%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 50.0%                                                                                                                   |

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|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Recommended reading                                            | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ol style="list-style-type: none"> <li>1. Konieczka P., The role of and place of method validation in the quality assurance and quality control (QA/QC) System, <i>Crit. Rev. Anal. Chem.</i>, 37, 173-190, 2007.</li> <li>2. Konieczka P., and Namieśnik J. eds., Kontrola i zapewnienie jakości wyników pomiarów analitycznych, WNT, Warsaw, 2017.</li> <li>3. International vocabulary of metrology Basic and general concepts and associated terms (VIM), Joint Committee for Guides in Metrology, JCGM 200:2012</li> <li>4. Wencławiak, B.W., Koch, M., and Hadjicostas E., (Eds.), Quality Assurance in Analytical Chemistry, Training and teaching, Second edition, Springer, 2014.</li> <li>5. ISO/IEC Guide 98-3:2008. Uncertainty of Measurement Part 3: Guide to the Expression of Uncertainty in Measurement (GUM: 1995).</li> </ol> <ul style="list-style-type: none"> <li>• ISO/IEC Guide 98-1:2024. Guide to the Expression of Uncertainty in Measurement (GUM) Part 1: Introduction</li> </ul> |
|                                                                | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Literature related to the subject matter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Example issues/<br>example questions/<br>tasks being completed | <ol style="list-style-type: none"> <li>1. Accuracy vs precision of measurement differences and significance.</li> <li>2. Systematic and random errors definitions and examples.</li> <li>3. Measurement traceability how to ensure it in a chemical laboratory.</li> <li>4. Primary and working standards role and examples.</li> <li>5. SI units in chemical analysis.</li> <li>6. Definition and significance of measurement uncertainty (according to GUM).</li> <li>7. Type A and type B evaluation of uncertainty components.</li> <li>8. Calculation of combined and expanded uncertainty; k factor.</li> <li>9. Main sources of uncertainty in chemical analysis.</li> <li>10. Stages of analytical method validation.</li> <li>11. Validation parameters (accuracy, precision, selectivity, LOD, LOQ, linearity).</li> <li>12. CRM (Certified Reference Material) role in ensuring measurement quality.</li> <li>13. Requirements of the PN-EN ISO/IEC 17025 standard in the field of chemical metrology.</li> <li>14. QC and QA differences and significance for accredited laboratories.</li> <li>15. The importance of measurement traceability for the comparability of results.</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Practical activities within the subject                        | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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