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| The title of the course | **Fundamentals of Metrology** |
| Faculty | [Faculty of Mechanical Engineering and Computer Science](http://eng.ath.bielsko.pl/index.php/faculties/gerg) |
| The level of studies | Engineer (BSc) |
| Semester | Winter/summer |
| The form of classes and number of hours | Lectures |
| Classes conducted for Polish students. Erasmus students can join them | Yes |
| Language of instruction | English |
| The number of ECTS | 3 |
| Teacher | Dr Eng. Wojciech Płowucha |
| The aims of the course  (maximum 500 characters) | To familiarize students with the theory and practice of measurement of various quantities (physical, mechanical, electrical, geometric). Lectures include issues of design of measuring instruments, errors introduced by particular sources (object, instrument, environment, observer ) and determination of measurement uncertainty. Lecture also addresses the subject of monitoring manufacturing processes, both in terms of the measurement equipment, as well as statistical techniques. |
| The content of the course: main topics and key ideas | 1. Introduction to metrology. The quantity, quantity value, measurement unit. The international system of units SI. Basic and derived quantities and units.  2. The theory of errors. Sources of errors and classification errors (measuring instrument, operator, environmental conditions, the object of measurement, measurement strategy). Correction and compensation of systematic errors. Systematic errors in indirect measurements.  3. A mathematical model of the measurement.  The statistical theory of errors. The normal distribution as a model of random errors.  4. Measurement uncertainty. Type A and B methods of the uncertainty evaluation. Probability distributions: normal, triangular, uniform, antimodal V, antimodal U. Standard and expanded measurement uncertainty. Calculation and expression of measurement uncertainty. Measurement uncertainty in indirect measurements.  5. Measuring instruments (analogue and digital).  Metrological characteristics of measuring instruments. Reference conditions (temperature, atmospheric pressure, the pressure of water vapor in the air). Accuracy. The maximum permissible errors.  6. Standard gauges. Transducers and comparators. AD, DA converters. Filtering of measurement data.  7. Computer methods in the measurements.  Statistical calculations, graphic protocols.  8. Methods and techniques for measuring electrical quantities.  9. Methods and techniques for the measurement of mechanical quantities.  10. Methods and techniques for measuring the gas and fluid quantities. The atmospheric pressure, flow velocity, etc.  11. Methods and techniques for measuring the chemical quantities.  12. Methods and techniques for the measurement of geometrical quantities. Measurements of length, angle, geometrical deviations (form, orientation, location and run-out), surface roughness. Coordinate measurement technique.  13. Calibration of measuring instruments. Traceability.  14. Monitoring of production processes  Statistical Process Control. Histogram, box-plot chart, charts for the probability distribution grids, process capability indexes. Control charts. |
| Didactics methods | Lecture |
| Course requirements | Exam/presentation/attendance/seminar paper |
| Literature (basic and supplementary) | 1. Webster J.G.: Measurement Instrumentation and Systems, CRC Press Inc. 2002  2. Humienny Z. (red.): Geometrical Product Specification (GPS). Wydawnictwa Naukowo-Techniczne. Warszawa 2002  3. GUM: Guide to the Expression of Uncertainty in Measurement (JCGM 100:2008, GUM 1995 with minor corrections)  4. VIM3: International Vocabulary of Metrology (JCGM 200:2012, VIM 3rd edition, 2008, with minor corrections) |
| The effects of the education   * knowledge * skills * social competences | - student has an elementary knowledge of metrology  - student can use analytical methods to analyze the results of measurement tasks  - student knows how to work with others and communicate using the correct metrological terms |