# Subject programme

1. Subject name / subject module: **Methodology of Scientific Research**
2. Lecture language: **English**
3. The location of the subject in study plans:
   - Area or areas of the studies: **Computer Control Systems Engineering**
   - Degree of the studies: **2nd degree studies**
   - Field or fields (implementation of effects standard): **Mechatronics**
4. Supervision of subject implementation:
   - The Institute / Another unit: **The Institute of Informatics and Mechatronics**
   - The person responsible for the subject: **Gireń Bolesław, dr hab. inż.**
   - People cooperating in the development of the programme of the subject:
5. The number of hours and forms of teaching for individual study system and the evaluation method

| Teaching activities with the tutor | | | | | | | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Form of classes / Mode of study | Lecture | SOW | ECTS | Workshop | SOW | ECTS | ... | SOW | ECTS | ... | SOW | ECTS | ... | SOW | ECTS | ... | SOW | ECTS | ... | SOW | ECTS | ECTS |
| Full-time studies | 14 | 11 | 2 | 14 | 11 | 1 | | | | | | | | | | | | | | | | 2 |
| Part-time studies | | | | | | | | | | | | | | | | | | | | | | |
| Credit rigor | Graded assigment | | | Graded assigment | | | | | | | | | | | | | | | | | | |

6. Student workload – ECTS credits balance
   *1 ECTS credit corresponds to 25-30 hours of student work needed to achieve the expected learning outcomes including the student's own work*

| **Activity**<br>(please specify relevant work for the subject) | **Hourly student workload (full-time studies/part-time studies)** |
|---|---|
| Participation in lectures | **14** |
| Participation in workshop classes | **14** |
| Independent study of the subject | **9** |
| Problem solving | **7** |
| Preparing a project | **4** |
| Participation in an exam / graded assignment / final grading | **2** |
| **Total student workload** | **50** |
| **ECTS credits** | **2** |
| * Student's workload related to practical forms | **25** |
| Student's workload in classes requiring direct participation of academic teachers | **28** |

7. Implementation notes: recommended duration (semesters), recommended admission requirements, relations between the forms of classes:

   None

   Recommended duration of the subject is taken from the course plan.
8. Specific learning outcomes – knowledge, skills and social competence

| Specific learning outcomes for the subject | | Form | Teaching method | Methods for testing of (checking, assessing) learning outcomes |
|---|---|---|---|---|
| Outcome symbol | Outcome description | | | |
| **Knowledge** | | | | |
| **K_W09** | **Student has structured and theoretically founded knowledge on methodology of scientific research, covering key issues, especially knowledge on the research process, research methods, methods for drawing the conclusions, specificity of the empirical research and research of the abstract nature. Student has knowledge on the verification of the hypothesis, assessment of errors and uncertainties, validation of the results and research** | **Lecture** | **Expository methods** | **Final test, student learning activites** |

| | | | | |
|---|---|---|---|---|
| | methods as well as practical application of these knowledge in mechatronics. | | | |
| Skills | | | | |
| K_U01 | Student is able to select and to obtain information necessary for the research from the literature and databases; Student is in addition able to interpret and critically analyse data, assess its relevant meaning and to establish proper correlations. Student can develop method for solving the research problem and appropriate plan of the research. | Workshop | Inquiry methods | Final test, student learning activites |
| K_U03 | Student is able to plan and carry out both empirical and computational research in mechatronics, especially laboratory experiments and simulations. Student is able to select methods and tools adequate to the research aims. Student can interpret the results and draw the conclusions. | | | |
| K_U05 | Student is able to use the knowledge on methodology to formulate scientific questions and to design various research processes, to validation of both the data and the results of the research. Student is able to use methods and tools for data analysis. Student can formulate the research hypothesis and test them with conclusive statistics methods. | | | |

**9.** Assessment rules / criteria for each form of education and individual grades

| | | | |
|---|---|---|---|
| **0% - 50%** | ndst | **81% - 90%** | db |
| **51% - 70%** | dst | **91% - 93%** | db+ |
| **71% - 80%** | dst+ | **94% - 100%** | bdb |

| Activity | Grades | Calculation | To Final |
|---|---|---|---|
| **project of the research** | **grade x** | **x** | **0.4*x** |
| **problems solved (10 problems)** | **grades xi** | **y = average of xi** | **0.4*y** |
| **test** | **z = score [%]** | **u=5*(z/100)** | **0.2*u** |

**10.** The learning contents with the form of the class activities on which they are carried out

**(Workshop)**

**Research; solving the research problem; research hypothesis; stages of the research - research process, research techniques and procedures; scientific method; fundamental methods for the research and drawing the conclusions; analysis, synthesis, deduction, induction; logical proving and inferring methods; experiment as a research method; observation as a research method; measurement and research tools; theory of measurement; model analysis and simulations as a research method; mathematical modelling and algorithms for solution; interpretation and verification of the results; validation and making reliable of the results of the research; validation of the method applied; standards; methods and techniques for analysis and transformation of knowledge; heuristic methods; research related to mechatronics; knowledge and science; ideas of epistemology; terminology and disciplines of science; errors and uncertainties in the research; methods for errors analysis and evaluation; statistical assessment and analysis of the results of the research; computation of the statistical measures; conclusive statistics – testing of the hypothesis.**

**11.** Required teaching aids

Lecture - multimedia projector

Exercises - a room adapted for conducting classes in the form of exercises / workshops, multimedia projector

**12.** Literature:

**a.** Basic literature:

https://www.academia.edu/33779875/C_R_Kothari_Research_Methodology_Methods_and_Techniques

**a.** Supplementary literature:

M.Chang, Principles of Scientific Methods, Chapman and Hall/CRC, 2014

A.M. Novikov, D.A. Novikov, Research Methodology. From Philosophy of Sciences to Research Design, CRC Press 2013

Vinayak Bairagi, Mousami V. Munot, Research Methodology: A Practical and Scientific Approach, Chapman and Hall/CRC Pub. 2019,

The Oxford Handbook of Epistemology (Oxford Handbooks), by Paul K. Moser,

Kumar R. (2005) Research Methodology – A Step-by-Step Guide for Beginners, London. Sage Pub.,

Panneerselvam R. (2004) Research Methodology. New Delpi. PHI Learning Pvt. Ltd.,

Fundamentals of research methodology and data collection (April 2016) Isbn: 978-3-659-86884-9, Pub. Lambert Academic Publishing,

Creswell J. (2002) Research Design. Qualitative, Quantitative and Mixed Method Approaches. London. Sage Publications,

Mayo, D.G., 1996, Error and the Growth of Experimental Knowledge, Chicago: University of Chicago Press,

**b.** Internet sources:

NIST/SEMATECH e-Handbook of Statistical Methods (2006), http://www.itl.nist.gov/div898/handbook/

S. Slutz, K.L. Hess, Data Analysis for Advanced Science Project, https://www.sciencebuddies.org/science-fair-projects/competitions/data-analysis-for-advanced-science-projects

Common errors made in research in, http://sociology.camden.rutgers.edu/jfm/tutorial/errors.htm

Muller, G. (2008). Systems Engineering Research Validation. http://www.gaudisite.nl/SEresearchValidationSlides.pdf

**13.** Available educational materials divided into forms of class activities (Author's compilation of didactic materials, e-learning materials, etc.)

**14.** Teachers implementing particular forms of education

| Form of education | Name and surname |
|---|---|
| 1. Lecture | Gireń Bolesław, dr hab. inż. |
| 2. Workshop classes | Gireń Bolesław, dr hab. inż. |