



## COURSE CARD

### 1. Basic information

|                                                                                                                                        |                                                                       |                                     |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|-------------------------------------|
| Course name in English:                                                                                                                | <b>Hardy Spaces and the Nevanlinna Class</b>                          |                                     |
| Course name in Polish:                                                                                                                 | <b>Przestrzeń Hardy'ego i Klasa Nevanlinny</b>                        |                                     |
| Number of hours:                                                                                                                       | 30                                                                    |                                     |
| Type of course:                                                                                                                        | Elective course                                                       |                                     |
| Form of course:                                                                                                                        | lecture                                                               |                                     |
| Code of course:                                                                                                                        |                                                                       |                                     |
| Course leader:                                                                                                                         | dr hab. Bartosz Trojan                                                |                                     |
| Faculty of the course leader:                                                                                                          | W13 Faculty of Pure and Applied Mathematics                           |                                     |
| Email address of the course leader:                                                                                                    | bartosz.trojan@pwr.edu.pl                                             |                                     |
| Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course): | Architecture and urban planning                                       | <input type="checkbox"/>            |
|                                                                                                                                        | Automation, electronic, electrical engineering and space technologies | <input type="checkbox"/>            |
|                                                                                                                                        | Information and communication technology                              | <input type="checkbox"/>            |
|                                                                                                                                        | Biomedical engineering                                                | <input type="checkbox"/>            |
|                                                                                                                                        | Chemical engineering                                                  | <input type="checkbox"/>            |
|                                                                                                                                        | Civil engineering, geodesy and transport                              | <input type="checkbox"/>            |
|                                                                                                                                        | Materials engineering                                                 | <input type="checkbox"/>            |
|                                                                                                                                        | Mechanical engineering                                                | <input type="checkbox"/>            |
|                                                                                                                                        | Environmental engineering, mining, and energy                         | <input type="checkbox"/>            |
|                                                                                                                                        | Mathematics                                                           | <input checked="" type="checkbox"/> |
|                                                                                                                                        | Chemical sciences                                                     | <input type="checkbox"/>            |
|                                                                                                                                        | Physical sciences                                                     | <input checked="" type="checkbox"/> |
|                                                                                                                                        | Management and quality studies                                        | <input type="checkbox"/>            |

### 2. Objectives

### 3. Content

*Detailed information about the course content, including topics and form of classes.*

| No. | Topic                             | Number of hours | Form of classes |
|-----|-----------------------------------|-----------------|-----------------|
| 1   | Review                            | 3               | lecture         |
| 2   | Holomorphic functions in the disk | 4               | lecture         |
| 3   | Hardy spaces                      | 7               | lecture         |
| 4   | Inner-outer factorization         | 6               | lecture         |
| 5   | Nevanlinna class                  | 4               | lecture         |



|   |                |   |         |
|---|----------------|---|---------|
| 6 | Pick functions | 6 | lecture |
|---|----------------|---|---------|

## 4. Prerequisites

*List of prerequisites relating to knowledge, skills and other competences for course participants.*

Complex Analysis, Measure Theory, Mathematical Analysis 2, Functional Analysis

## 5. Learning outcomes

*List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course  
(mark the learning outcomes in the last column).*

| Symbol | Learning outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                     |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
|        | <i>KNOWLEDGE. Doctoral student knows and understands:</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                     |
| SzD_W3 | the main trends in the development of the scientific or artistic disciplines covered in the curricula;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <input checked="" type="checkbox"/> |
| SzD_W4 | research methodology;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <input type="checkbox"/>            |
| SzD_W5 | the rules for the dissemination of scientific results, including in open access mode;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <input type="checkbox"/>            |
| SzD_W6 | the fundamental dilemmas of modern civilization;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <input type="checkbox"/>            |
| SzD_W7 | the legal and ethical conditions of scientific activity;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <input type="checkbox"/>            |
| SzD_W8 | the economic and other relevant conditions of scientific activity;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <input type="checkbox"/>            |
| SzD_W9 | basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <input type="checkbox"/>            |
|        | <i>SKILLS. Doctoral student is able to:</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                     |
| SzD_U2 | use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:<br>- define the purpose and subject of scientific research, formulate a research hypothesis,<br>- develop research methods, techniques and tools, and use them creatively,<br>- draw conclusions on the basis of scientific research;<br>critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development;<br>transfer the results of scientific activities to the economic and social spheres; | <input checked="" type="checkbox"/> |
| SzD_U3 | communicate on specialised topics to the extent that they enable an active participation in the international scientific community;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <input type="checkbox"/>            |
| SzD_U4 | disseminate research results, including in popular forms;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <input type="checkbox"/>            |
| SzD_U5 | initiate debates and participate in a scientific discourse;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <input type="checkbox"/>            |
| SzD_U6 | be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment;                                                                                                                                                                                                                                                                                                                                                                                                                                          | <input type="checkbox"/>            |
| SzD_U7 | plan and implement an individual or collective research or creative activity, including in an international environment;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <input type="checkbox"/>            |



|        |                                                                                                                                                                                                                                                                                                         |                                     |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| SzD_U8 | independently plan and act for one's own development and inspire and organize the development of others;                                                                                                                                                                                                | <input type="checkbox"/>            |
| SzD_U9 | plan classes or groups of classes and implement them using modern methods and tools.                                                                                                                                                                                                                    | <input type="checkbox"/>            |
|        | <b><i>SOCIAL COMPETENCES. Doctoral student is ready to:</i></b>                                                                                                                                                                                                                                         |                                     |
| SzD_K3 | fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;                                                                                                                                                      | <input type="checkbox"/>            |
| SzD_K4 | maintaining and developing the ethos of research and creative environments, including:<br>- carrying out scientific activities in an independent manner,<br>- respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection. | <input checked="" type="checkbox"/> |

## 6. Evaluation

*Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.*

homework

## 7. Teaching methods

*Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.*

discussion, literature studies, own work

## 8. Literature

*List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.*

**Conway, Functions of One Complex Variable I**

**Duren, Theory of  $H^p$  Spaces**

**Donoghue, Monotone Matrix Functions and Analytic Continuation**

**Garnett, Bounded Analytic Functions**

**Hayman, Meromorphic Functions**

**Koosis, Introduction to  $H^p$  Spaces**

**Koosis, The Logarithmic Integral I**

**Rudin, Real and Complex Analysis**

**Stein, Shakarchi, Complex Analysis**

## 9. Other remarks

*Additional remarks, comments, (e.g., language of the course)*

In Polish or English