



## COURSE CARD

### 1. Basic information

|                                                                                                                                        |                                                    |                                     |
|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-------------------------------------|
| Course name in English:                                                                                                                | Advanced Organic Chemistry                         |                                     |
| Course name in Polish:                                                                                                                 | Zaawansowana Chemia Organiczna                     |                                     |
| Number of hours:                                                                                                                       | 30                                                 |                                     |
| Type of course:                                                                                                                        | Elective course                                    |                                     |
| Form of course:                                                                                                                        | lecture                                            |                                     |
| Code of course:                                                                                                                        |                                                    |                                     |
| Course leader:                                                                                                                         | <i>Dr hab. inż. Rafał kowalczyk</i>                |                                     |
| Faculty of the course leader:                                                                                                          | W3 Faculty of Chemistry                            |                                     |
| Email address of the course leader:                                                                                                    | rafal.kowaczyk@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, and electrical engineering | <input type="checkbox"/>            |
|                                                                                                                                        | Information and communication technology           | <input type="checkbox"/>            |
|                                                                                                                                        | Biomedical engineering                             | <input type="checkbox"/>            |
|                                                                                                                                        | Chemical engineering                               | <input type="checkbox"/>            |
|                                                                                                                                        | Civil engineering and transport                    | <input type="checkbox"/>            |
|                                                                                                                                        | Mechanical engineering                             | <input type="checkbox"/>            |
|                                                                                                                                        | Environmental engineering, mining, and energy      | <input type="checkbox"/>            |
|                                                                                                                                        | Mathematics                                        | <input type="checkbox"/>            |
|                                                                                                                                        | Chemical sciences                                  | <input checked="" type="checkbox"/> |
|                                                                                                                                        | Physical sciences                                  | <input type="checkbox"/>            |
|                                                                                                                                        | Management and quality studies                     | <input type="checkbox"/>            |

### 2. Objectives

C1 The relationship of the electronic structure of organic compounds, carbocations, carbenes, radicals and carbanions with their properties and reactivity in the light of the theory of molecular orbitals and VBO

C2 Acidity, basicity, nucleophilicity and electrophilicity as structural factors of an organic compound that determine the course of a reaction

C3 How to determine reaction mechanism?

C4 Indication the postulates of the transition state theory in terms of optimization of the reaction course

C5 Presentation of the basic methods of modifications of the reactivity of organic compounds by means of changing the reaction medium or reaction conditions (temperature, concentration)

C6 The relationship between the transition state and the possibility of catalysis. Introduction to electrophilic and nucleophilic catalysis, general and specific acid and base catalysis

C7 Demonstration how the reaction mechanism interferes with a reaction medium and concentration factors and the subsequent impact on the course of reactions important for modern organic synthesis



### 3. Content

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

| No. | Topic                                                                       | Number of hours | Form of classes |
|-----|-----------------------------------------------------------------------------|-----------------|-----------------|
| 1   | New look into the bonding in organic chemistry                              | 4               | lecture         |
| 2   | Structure of the molecule determines the stability and the reactivity       | 2               | lecture         |
| 3   | Acids and bases, nucleophiles and electrophiles                             | 2               | lecture         |
| 4   | Molecular orbitals and HSAB theory. Klopman-Salem equation                  | 2               | lecture         |
| 5   | Bonds weaker than covalent as an extra-stabilizing interaction              | 2               | lecture         |
| 6   | Transition state theory                                                     | 2               | lecture         |
| 7   | Catalysis as the only way to chemistry 2.0                                  | 4               | lecture         |
| 8   | Mechanisms of the crucial reactions applied in the modern organic synthesis | 10              | lecture         |
| 9   |                                                                             |                 | Select form     |
| 10  |                                                                             |                 | Select form     |
| 11  |                                                                             |                 | Select form     |
| 12  |                                                                             |                 | Select form     |
| 13  |                                                                             |                 | Select form     |
| 14  |                                                                             |                 | Select form     |
| 15  |                                                                             |                 | Select form     |

### 4. Prerequisites

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

1. Physical Chemistry (basic level)
2. Organic Chemistry (medium level)

### 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                                                                                       |                                     |
|--------|--------------------------------------------------------------------------------------------------------|-------------------------------------|
|        | <b>KNOWLEDGE.</b> Doctoral student knows and understands:                                              |                                     |
| 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 checked="" 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 checked="" 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 checked="" 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"/>            |
| <i>SOCIAL COMPETENCES. Doctoral student is ready to:</i> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                     |
| SzD_K3                                                   | fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <input checked="" 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 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.*

Evaluation of the learning outcomes: exam

## 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.*



lecture with multimedia presentation, discussion, literature studies

## 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.*

Primary literature

- [1] F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Springer, 2007
- [2] M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th Edition, Wiley, 2013
- [3] E. V. Anslyn, D. A. Dougherty, Modern Physical Organic Chemistry, University Science Books, 2006

Secondary literature

J. Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2001

## 9. Other remarks

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

Lecture in English