



## COURSE CARD

### 1. Basic information

Course name in English:	Modelling of physical processes and phenomena using Computer Algebra Systems	
Course name in Polish:	Modelowanie zjawisk i procesów fizycznych metodami algebry komputerowej	
Number of hours:	30	
Type of course:	Elective course	
Form of course:	lecture	
Code of course:	W11NAF-SD0077W / NFQ100366W	
Course leader:	prof. dr hab. Antoni C. Mitus	
Faculty of the course leader:	W11 Faculty of Fundamental Problems of Technology	
Email address of the course leader:	antoni.mitus@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 checked="" type="checkbox"/>
	Information and communication technology	<input checked="" type="checkbox"/>
	Biomedical engineering	<input checked="" type="checkbox"/>
	Chemical engineering	<input checked="" type="checkbox"/>
	Civil engineering and transport	<input checked="" type="checkbox"/>
	Mechanical engineering	<input checked="" type="checkbox"/>
	Environmental engineering, mining, and energy	<input checked="" type="checkbox"/>
	Mathematics	<input checked="" type="checkbox"/>
	Chemical sciences	<input checked="" type="checkbox"/>
	Physical sciences	<input checked="" type="checkbox"/>
	Management and quality studies	<input checked="" type="checkbox"/>

### 2. Objectives

C1 Acquire basic skill in using CAS *Maple*

C2 Acquire skills to use Maple for solving chosen problems in physics and for modeling of chosen phenomena and processes in physics

### 3. Content

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

No.	Topic	Number of hours	Form of classes
1	Introduction into <i>Maple</i> : basic features of the programming language	6	lecture
2	Introduction into <i>Maple</i> : elementary applications in mathematics and physics	4	lecture
3	Variations on harmonic oscillator	4	lecture



4	Oregonator: chemical reactions with oscillations	2	lecture
5	Mathieu's oscillator, parametric resonance	2	lecture
6	Phase portraits. Van der Pol's limit cycle	2	lecture
7	Period doubling and chaos: Duffing's equation	2	lecture
8	Van der Pol's equation: chaos.	2	lecture
9	Calculus of variations: Fermat's principle, chaotic pendulum, geodesics	3	lecture
10	Partial differential equations: string oscillations, diffusion	3	lecture

#### 4. Prerequisites

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

1. Basic programming skills
2. Basic English language

#### 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 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: - define the purpose and subject of scientific research, formulate a research hypothesis, - develop research methods, techniques and tools, and use them creatively, - draw conclusions on the basis of scientific research; critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development; 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"/>
<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 type="checkbox"/>
SzD_K4	maintaining and developing the ethos of research and creative environments, including: - carrying out scientific activities in an independent manner, - 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.*

Examination (presentation), discussion during the lecture, computer lab activities during the lecture

## 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.*

N1. Lecture

N2. Computer lab (during the lecture)

## 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.*

- [1] R.H. Enns, *Computer Algebra Recipes for Mathematical Physics* (Birkhauser, Boston, 2005)
- [2] R.H. Enns, G.C. McGuire, *An Advanced Guide to Scientific Modeling* (Springer, New York, 2007)
- [3] A.C. Mituś, R. Orlik, G. Pawlik, *Wstęp do pakietu algebry komputerowej Maple* (Oficyna Wydawnicza DWSPiT, Polkowice, 2010)



## 9. Other remarks

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