

**FACULTY OF PURE AND APPLIED MATHEMATICS  
SUBJECT CARD**

**Name in Polish: Równania różniczkowe cząstkowe z zastosowaniami w fizyce i przemyśle**

**Name in English: Partial differential equations with applications in physics and industry**

**Main field of study (if applicable): APPLIED MATHEMATICS**

**Specialization (if applicable): MATHEMATICS FOR INDUSTRY AND COMMERCE**

**Level and form of studies: 1st/ 2nd\* level, full-time / ~~part-time~~\***

**Kind of subject: obligatory / ~~optional~~ / ~~university-wide~~\***

**Subject code**

**Group of courses YES / NO\***

|  | Lecture  | Classes                             | Laboratory                          | Project                             | Seminar                             |
|--|--|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Number of hours of organized classes in University (ZZU)   | 30   | 30                                  |                                     |                                     |                                     |
| Number of hours of total student workload (CNPS)   | 120  | 60                                  |                                     |                                     |                                     |
| Form of crediting  | Examination / <del>crediting with grade*</del> | Examination / crediting with grade* | Examination / crediting with grade* | Examination / crediting with grade* | Examination / crediting with grade* |
| For group of courses mark (X) final course   | X  |                                     |                                     |                                     |                                     |
| Number of ECTS points  | 3  | 3                                   |                                     |                                     |                                     |
| including number of ECTS points for practical classes (P)  |  | 4                                   |                                     |                                     |                                     |
| including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU) | 1  | 2                                   |                                     |                                     |                                     |

\*delete as not necessary

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Student knows and can apply classical notions and methods of real and complex analysis.
2. Student knows and can apply elementary notions and methods of ordinary differential equations.

**SUBJECT OBJECTIVES**

- C1 Study of basic notions and acquisition of knowledge in the area of differential equations.  
 C2 Study of basic applications of partial differential equations in science, technology and industry.  
 C3 Acquisition of basic abilities in mathematical modelling by partial differential equations.

### SUBJECT EDUCATIONAL EFFECTS

relating to knowledge the student:

PEK\_W01 knows the most important theorems from main areas of differential equations

PEK\_W02 knows basics of modelling by differential equations in technology and natural sciences, especially in physics, chemistry and biology.

relating to skills the student:

PEK\_U01 can analyze basic problems of differential equations,

PEK\_U02 can construct mathematical models with the usage of differential equations in concrete applications of mathematics.

relating to social competences the student:

PEK\_K01 can, without assistance, search for necessary information in the literature, also in foreign languages

PEK\_K02 understands necessity of systematic and individual work on the material of the course.

### PROGRAMME CONTENT

| Form of classes - lecture |   | Number of hours |
|---------------------------|---|-----------------|
| Lec1                      | A reminder of information concerning first order partial differential equations. Methods of characteristics, weak solutions and shock waves.  | 4               |
| Lec2                      | Second order partial differential equations and their classification. Physical motivations.   | 2               |
| Lec3                      | Parabolic equations and their applications (heat, diffusion). Initial-boundary problems, method of separation of variables, Fourier transform, fundamental solution, maximum principle.   | 8               |
| Lec4                      | Hyperbolic equations and their applications (vibration of strings, membranes and beams; acoustical, mechanical and electromagnetic waves). D'Alembert's solution, initial-boundary problems, method of separation of variables, Kirchhoff's solution, Huygens' principle. | 8               |
| Lec5                      | Elliptic equations and their applications (stationary temperature distribution, gravitational and electrostatic potential). Boundary value problems, eigenfunctions, Poisson's equation, Green's function.  | 6               |
| Lec6                      | The calculus of variations and its applications. Euler-Lagrange equation, Lagrangian mechanics, geodesic equation, minimal surface equation.  | 2               |
|                           | Total hours   | <b>30</b>       |

| Form of classes - Class |  | Number of hours |
|-------------------------|--|-----------------|
| Cl1                     | Solving of problems for differential equations and their applications. | <b>30</b>       |
|                         | Total hours  | <b>30</b>       |

### TEACHING TOOLS USED

1. Lecture – traditional method
2. Tutorial class
3. Consultations
4. Student's personal work – preparation for the laboratory

### EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

| Evaluation (F – forming during semester), P – concluding (at semester end) | Learning outcomes code        | Way of evaluating learning outcomes achievement |
|--|-------------------------------|---|
| F1   | PEK_W01<br>PEK_W02<br>PEK_K01 | exam  |
| F2   | PEK_U01<br>PEK_U02<br>PEK_K01 | Oral presentations, tests, written reports.     |
| $P=0.5 \cdot F1 + 0.5 \cdot F2$  |                               |   |

### PRIMARY AND SECONDARY LITERATURE

#### **PRIMARY LITERATURE:**

- [1] S.J.Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993.
- [2] R.Haberman, Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, Pearson, 2012.
- [3] A. N. Tichonow, A. A. Samarski, Równania fizyki matematycznej, PWN 1963.

#### **SECONDARY LITERATURE:**

- [1] J. Ockendon, S. Howison, A. Lacey & A. Movchan, Applied Partial Differential Equations, Oxford University Press, Oxford 1999.
- [2] L. C. Evans, Równania różniczkowe cząstkowe, PWN 2002.

#### **SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)**

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