FACULTY OF ARCHITECTURE

SUBJECT CARD

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| English name | **ELEMENTS OF HIGHER MATHEMATICS** |
| Polish name | **ELEMENTY MATEMATYKI WYŻSZEJ** |
| Main field of study | ***Spatial Planning*** |
| Level and form of studies | **II level, full time** |
| Kind of subject | **obligatory** |
| Subject code | **MAT001675** |
| Group of courses | **NO** |

| | Lecture | Classes | Laboratory | Project | Seminar |
|---|---|---|---|---|---|
| Number of hours of organized classes in University (ZZU) | 30 | | | | |
| Number of hours of total student workload (CNPS) | | | | | |
| Form of crediting | crediting with grade | | | | |
| In case of a group of courses, mark the final course (X) | | | | | |
| Number of ECTS points | 2 | | | | |
| including number of ECTS points for practical (P) classes | | | | | |
| including number of ECTS points for direct teacher-student contact (BK) classes | | | | | |

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

Knowledge of mathematics equivalent to high school certificate at the advanced level is recommended.

**SUBJECT OBJECTIVES**

C1 Explaining the basic notions and examples in topology.
C2 Presenting the basic information on graph theory with an emphasis on applications.
C3 A basic exposition of cellular automata and their applications.
C4 Explaining the basics of statistical testing.

**SUBJECT EDUCATIONAL EFFECTS**

**Relating to knowledge a student**

PEK_W1 knows the definition and basic examples of metric spaces, understands the notion of convergence and continuity, knows some basic examples of metric spaces,
PEK_W2 has basic knowledge of graph theory and its role in applications,
PEK_W3 has a basic understanding of cellular automata,
PEK_W4 has a basic knowledge of statistical hypothesis testing.

**Relating to skills a student**

PEK_U1 can investigate the basic properties of metric spaces and can use the basic notions of metric topology,

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| PEK_U2 can solve elementary problems in graph theory, can apply graph theory to other areas of science and can formulate application problems in the language of graph theory,<br>PEK_U3 can use basic statistical tests for comparing distributions of statistical samples. |

| **PROGRAMME CONTENT** | | |
|---|---|---|
| **Form of classes - lectures** | | **Hours** |
| Lec1 | Basic notions in topology. Open sets. Topological spaces. Metrics. Continuous maps. Homeomorphisms. Compactness. Connectedness. Examples. | 4 |
| Lec2 | The notion of dimension, with intuitive understanding and formal definitions. The Minkowski dimension (the "box-counting" dimension). Fractals as sets of non-integer dimension. | 2 |
| Lec3 | Special types of fractals: the Cantor and Sierpinski sets. IFS fractals, such as Barnsley's fern. Examples of real-life objects and phenomena which exhibit fractal character. | 2 |
| Lec4 | Introduction to graph theory. Basic definitions and notions in graph theory. Representing graphs using matrices. Graph isomorphism. | 2 |
| Lec5 | Paths and cycles in graphs. Eulerian and Hamiltonian graphs. The Chinese postman problem and the traveling salesman problem. | 2 |
| Lec6 | Trees, planar graphs and the Euler formula. | 2 |
| Lec7 | Coloring graphs: the chromatic number and the chromatic index. The four-color theorem, and contrasting the situation on a plane with surfaces of other genus. | 2 |
| Lec8 | Matchings in bipartite graphs. Transversals. The Hall and Menger theorems. | 2 |
| Lec9 | Directed graphs. Network flow analysis. The Ford-Fulkerson algorithm. | 2 |
| Lec10 | Analyzing networks. Vertex degree distribution, distance statistics, clusters. | 2 |
| Lec11 | Randomized networks. Statistical properties of random graphs. The small-world phenomenon. Scale-free networks. | 2 |
| Lec12 | The definition of cellular automata. Examples of cellular automata: Wolfram's "Rule 90", Conway's "Life". Cellular automata on the plane: Moore and von Neumann neighborhoods. Possible behaviors: stability, periodicity, chaos. Using cellular automata for modeling real-life phenomena. | 2 |
| Lec13 | Basic notions in statistical hypothesis testing: statistical tests, the two kinds of errors, significance, critical value, critical area, the power of a test. | 2 |
| Lec14 | Tests for mean and variance of statistical samples, independence tests. | 2 |
| | **Total hours** | **30** |

| **TEACHING TOOLS USED** |
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| N1 Lectures – traditional and using multimedia tools.<br>N2 Tutorial.<br>N3 Student's self-study. |

**EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT**

| Evaluation: F – forming (during the semester), P – concluding (at the end of the semester) | Educational effect number | Way of evaluating educational effect achievement |
|---|---|---|
| F | PEK_U1-PEK_U3<br>PEK_W1-PEK_W4 | final test |
| P – rules set by the lecturer | | |

| PRIMARY AND SECONDARY LITERATURE |
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| **PRIMARY LITERATURE**<br>[1] I. Kaplansky, Set theory and metric spaces.<br>[2] R. J. Wilson, Introduction to Graph Theory.<br><br>**ADDITIONAL LITERATURE**<br>[1] J.R. Weeks, The Shape of Space.<br>[2] M. Batty, Cities and Complexity. |

| SUBJECT SUPERVISOR (NAME AND E-MAIL) |
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| Wydziałowa Komisja Programowa ds. Kursów Ogólnouczelnianych<br>dr inż. Dawid Huczek (Dawid.Huczek@pwr.edu.pl) |

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
**ELEMENTS OF HIGHER MATHEMATICS MAT001675**
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY ***Spatial Planning***

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable) | Subject objectives | Programme content | Teaching tool number |
|---|---|---|---|---|
| PEK_W1 | K2GP_W01 | C1 | Lec1-Lec3 | N1-N3 |
| PEK_W2 | K2GP_W01 | C2 | Lec4-Lec9 | N1-N3 |
| PEK_W3 | K2GP_W02 | C3 | Lec10-Lec12 | N1-N3 |
| PEK_W4 | K2GP_W02 | C4 | Lec13, Lec14 | N1-N3 |
| PEK_U1 | | C1 | Lec1-Lec3 | N1-N3 |
| PEK_U2 | K2GP_U03 | C2 | Lec4-Lec9 | N1-N3 |
| PEK_U3 | K2GP_U03, K2GP_U15 | C4 | Lec13, Lec14 | N1-N3 |