

## Subject card

|                                             |                                                                                                                                                                                                                                                                                                                                      |                                                          |                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                     |            |     |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|-------------------------------------------------------------------------------------|------------|-----|
| Subject name and code                       | Digital Image Processing Algorithms, PG_00179345                                                                                                                                                                                                                                                                                     |                                                          |                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                     |            |     |
| Field of study                              | Algorytmy przetwarzania obrazów cyfrowych                                                                                                                                                                                                                                                                                            |                                                          |                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                     |            |     |
| Date of commencement of studies             | October 2023                                                                                                                                                                                                                                                                                                                         |                                                          | Academic year of realisation of subject                                                                                                                                                                                                                                                                                                                  |                                     | 2025/2026                                                                           |            |     |
| Education level                             | Bachelor's studies                                                                                                                                                                                                                                                                                                                   |                                                          | Subject group                                                                                                                                                                                                                                                                                                                                            |                                     | Obligatory subject group in the field of study<br>Optional subject group            |            |     |
| Mode of study                               | full-time studies                                                                                                                                                                                                                                                                                                                    |                                                          | Mode of delivery                                                                                                                                                                                                                                                                                                                                         |                                     | at the university                                                                   |            |     |
| Year of study                               | 3                                                                                                                                                                                                                                                                                                                                    |                                                          | Language of instruction                                                                                                                                                                                                                                                                                                                                  |                                     | Polish                                                                              |            |     |
| Semester of study                           | 5                                                                                                                                                                                                                                                                                                                                    |                                                          | ECTS credits                                                                                                                                                                                                                                                                                                                                             |                                     | 5.0                                                                                 |            |     |
| Learning profile                            | practical                                                                                                                                                                                                                                                                                                                            |                                                          | Assessment form                                                                                                                                                                                                                                                                                                                                          |                                     | exam                                                                                |            |     |
| Conducting unit                             |                                                                                                                                                                                                                                                                                                                                      |                                                          |                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                     |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                                                                                                                                   |                                                          | dr inż. Agnieszka Rowińska-Schwarzweiler                                                                                                                                                                                                                                                                                                                 |                                     |                                                                                     |            |     |
|                                             | Teachers                                                                                                                                                                                                                                                                                                                             |                                                          | dr inż. Agnieszka Rowińska-Schwarzweiler                                                                                                                                                                                                                                                                                                                 |                                     |                                                                                     |            |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                                                                                                                                          | Lecture                                                  | Tutorial                                                                                                                                                                                                                                                                                                                                                 | Laboratory                          | Project                                                                             | Seminar    | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                                                                | 30.0                                                     | 0.0                                                                                                                                                                                                                                                                                                                                                      | 30.0                                | 0.0                                                                                 | 0.0        | 60  |
|                                             | E-learning hours included: 0.0                                                                                                                                                                                                                                                                                                       |                                                          |                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                     |            |     |
|                                             | Additional information:<br><br>Podstawowe zasady, metody i algorytmy są wyjaśniane na wykładach. W ćwiczeniach laboratoryjnych, które odbywają się równolegle, rozwiązywane są zadania teoretyczne i praktyczne (metody i algorytmy są stosowane i ew. implementowane w sposób wzorcowy w oparciu o ImageJ i/lub python i/lub java). |                                                          |                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                     |            |     |
| Learning activity and number of study hours | Learning activity                                                                                                                                                                                                                                                                                                                    | Participation in didactic classes included in study plan |                                                                                                                                                                                                                                                                                                                                                          | Participation in consultation hours |                                                                                     | Self-study | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                                                                | 60                                                       |                                                                                                                                                                                                                                                                                                                                                          | 0.0                                 |                                                                                     | 0.0        | 60  |
| Subject objectives                          | Qualification aim of this module is to impart methods for digital image processing as subset of digital signal processing: algorithms for image reconstruction, enhancement, filtering, correlation, object feature detection, segmentation, classification and pattern recognition.                                                 |                                                          |                                                                                                                                                                                                                                                                                                                                                          |                                     |                                                                                     |            |     |
| Learning outcomes                           | Course outcome                                                                                                                                                                                                                                                                                                                       |                                                          | Subject outcome                                                                                                                                                                                                                                                                                                                                          |                                     | Method of verification                                                              |            |     |
|                                             | [INFL3_U08] assesses the usefulness of various paradigms and related programming tools to solve various types of problems                                                                                                                                                                                                            |                                                          | Students can design and implement a simple image processing algorithm and evaluate its accuracy. Students can select appropriate algorithms to solve a specific image analysis problem (e.g., noise reduction, edge detection, segmentation).                                                                                                            |                                     | [SU2] prezentacja/projekt/referat/ raport<br>[SU4] test/egzamin - ustny lub pisemny |            |     |
|                                             | [INFL3_U01] can apply mathematical knowledge to formulate, analyse and solve tasks related to computer science, design and analyze algorithms in terms of their correctness and computational complexity                                                                                                                             |                                                          | The student is able to apply mathematical methods to digital image operations (e.g., convolution, Fourier transform). The student is able to use mathematical tools for image analysis and processing (e.g., transforms, filtration methods, mathematical morphology) and is familiar with examples of algorithms used for segmentation and compression. |                                     | [SU4] test/egzamin - ustny lub pisemny                                              |            |     |

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| Subject contents                                               | <ul style="list-style-type: none"><li>• Human visual perception / color space models</li><li>• Image representation (image as a two-dimensional signal, resolution change, color palette change - dithering)</li><li>• Image digitization (sampling, Nyquist-Shannon theorem, quantization)</li><li>• Discretization in signal and systems theory (DFT, DFC, FFT)</li><li>• Point operators (based on histogram, arithmetic and logical operations on images)</li><li>• Linear filters in the image domain (convolution) and in the frequency domain</li><li>• Nonlinear filters</li><li>• Image correlation</li><li>• Morphological operations</li><li>• Detection of object features in images (edges, ridges, angles, texture)</li><li>• Segmentation of objects in the image</li><li>• Classification</li><li>• Neural networks in image processing</li><li>• Applications (measurement techniques, biometric technologies)</li></ul> |                                                                                                                                                                                                               |                               |
| Prerequisites and co-requisites                                | no prerequisites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                               |                               |
| Assessment methods and criteria                                | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Passing threshold                                                                                                                                                                                             | Percentage of the final grade |
|                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 51.0%                                                                                                                                                                                                         | 10.0%                         |
|                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 51.0%                                                                                                                                                                                                         | 90.0%                         |
| Recommended reading                                            | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | "Cyfrowe przetwarzanie obrazów", 2008, W. Malina, M. Smiatacz<br>"Digital Image Processing Second Edition", 2019, Gonzalez, Faisal<br>"Basics of Image Processing", 2025, V. Mazet (Université de Strasbourg) |                               |
|                                                                | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | "Digital Signal Processing", A.V. Oppenheim, R. Schafer                                                                                                                                                       |                               |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                               |                               |
| Example issues/<br>example questions/<br>tasks being completed |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                               |                               |
| Work placement                                                 | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                               |                               |

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