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

**Name in Polish: Wstep do matematycznych metod przetwarzania obrazu**
**Name in English: Introduction to Mathematical Image Processing**
**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 MAP1898**
**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) | 90 | | 90 | | |
| Form of crediting | ~~Examination~~ / crediting with grade* | 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 (P) classes | | | 3 | | |
| including number of ECTS points for direct teacher-student contact (BK) classes | 1,5 | | 1,5 | | |

*delete as applicable

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

1. Student knows basic concepts of functional analysis
2. Knows basic concepts of theory of partial differential equations
3. Knows and can apply basic methods of variational calculus
4. Knows at least one package for mathematical computing
5. Knows basic numerical methods for solving partial differential equations

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**SUBJECT OBJECTIVES**

C1 Study of fundamental mathematical models in image processing
C2 Study of numerical methods for solving problems of filtering, segmentation and decomposition of image
C3 Application of acquired knowledge to construction and analysis of mathematical models in image processing

| SUBJECT EDUCATIONAL EFFECTS |
|---|
| relating to knowledge:<br>PEK_W01 knows basic models of image filtering<br>PEK_W02 knows basic models of image segmentation<br>PEK_W03 knows the Meyer decomposition model<br>PEK_W04 knows numerical methods for solving fundamental problems in image processing<br><br>relating to skills:<br>PEK_U01 be able to demonstrate the equivalence of known models of image filtering<br>PEK_U02 be able to demonstrate the equivalence of known models of image segmentation<br>PEK_U03 be able to apply numerical methods to solve approximate solutions to mathematical models in image processing<br><br>relating to social competences:<br>PEK_K01 can, without assistance, search for necessary information in the literature.<br>PEK_K02 understands the need for systematic work on course material |

| PROGRAMME CONTENT | | |
|---|---|---|
| **Form of classes - lecture** | | **Number of hours** |
| Lec 1 | Overview of fundamental problems in image processin. Image degradation models | 2 |
| Lec 2 | Models of image denoising: linear diffusion filter, nonlinear diffusion filters, variational models for image denoising, wavelets models for image denoising, nonlocal filters. | 12 |
| Lec 3 | Discretization of selected image denoising model | 2 |
| Lec 4 | Models of image segmentation: variational model of Mumford-Shah and its approximations, stochastic model of Geman-Geman, active contours model | 8 |
| Lec 5 | Discretization of selected image segmantation model | 2 |
| Lec 6 | Image decomposition model of Meyer and methods of its solution | 4 |
| | Total hours | **30** |

| **Form of classes - laboratory** | | **Number of hours** |
|---|---|---|
| Lab 1 | Basic operation on images. Degradation of images | 2 |
| Lab 2 | Implementation of nonlinear diffusion filter | 6 |
| Lab 3 | Implemantation of the algorithm for minimization of the Rudin, Osher and Fatemi model | 4 |
| Lab 4 | Implementation of the algorithm for minimization of the Mumfors-Shah model | 6 |
| Lab 5 | Implementation of evolution equation related with the active contour model | 6 |
| Lab 6 | Implementation of the algorithm for image decomposition | 6 |
| | Total hours | **30** |

| TEACHING TOOLS USED |
| --- |
| N1. Lecture – traditional method supported by multimedial presentation<br>N2. Computer laboratory – working on a computer using a software package for numerical computations<br>N3. Consultations<br>N4. Student's self work – preparation for the laboratory |

**EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT**

| **Evaluation** (F – forming (during semester), P – concluding (at semester end) | Educational effect number | Way of evaluating educational effect achievement |
| --- | --- | --- |
| F1 | PEK_W04, PEK_U03, PEK_K01, | activity in the laboratory, oral presentation, projects, raports |
| F2 | PEK_W01, PEK_W02, PEK_W03, PEK_W04, PEK_U01, PEK_U02, PEK_U03, PEK_K01, PEK_K02, | test |
| P==0.5*F1+0.5*F2 | | |

**PRIMARY AND SECONDARY LITERATURE**

**PRIMARY LITERATURE:**


[1] G. Aubert and P. Kornprobst „Mathematical Problems in Image Processing: Partial Differential Equations and the Calculus of Variations", Springer-Verlag, 2007.

[2] T. Chan and J. Shen „Image Processing And Analysis: Variational, PDE, Wavelet, And Stochastic Methods", SIAM, 2006.


**SECONDARY LITERATURE:**


[1] O. Scherzer (Editor) „Handbook of Mathematical Methods in Imaging", Springer-Verlag, 2010.


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


Dr Monika Muszkieta (Monika.Muszkieta@pwr.wroc.pl)

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

**Introduction to Mathematical Image Processing MAP1898**

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

**APPLIED MATHEMATICS**

AND SPECIALIZATION **MATHEMATICS FOR INDUSTRY AND COMMERCE**

| **Subject educational effect** | **Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**lności (o ile dotyczy)** | **Subject objectives*** ** | **Programme content*** ** | **Teaching tool number*** ** |
|---|---|---|---|---|
| **PEK_W01 (knowledge)** | K2MIC_W04, K2MIC_W06, K2MIC_W07, K2MIC_W13 | C1, C3 | Lec 1, Lec 2, Lab 2, Lab 3 | 1, 2, 3 |
| **PEK_W02** | K2MIC_W04, K2MIC_W06, K2MIC_W07, K2MIC_W13 | C1, C3 | Lec 1, Lec 4, Lab 4, Lab 5 | 1, 2, 3 |
| **PEK_W03** | K2MIC_W04, K2MIC_W06, K2MIC_W07, K2MIC_W13 | C1, C3 | Lec 6, Lab 6 | 1, 2, 3 |
| **PEK_W04** | K2MIC_W08, K2MIC_W10, K2MIC_W12, K2MIC_W13 | C2 | Lec 3, Lec 5, Lab 1-Lab 6 | 1, 2, 3, 4 |
| **PEK_U01 (skills)** | K2MIC_U04, K2MIC_U05, K2MIC_U06, K2MIC_U09 | C1, C3 | Lec 2, Lab 2, Lab 3 | 1, 2, 3 |
| **PEK_U02** | K2MIC_U04, K2MIC_U05, K2MIC_U06, K2MIC_U09 | C1, C3 | Lec 4, Lab 4, Lab 5 | 1, 2, 3 |
| **PEK_U03** | K2MIC_U16, K2MIC_U17 | C2 | Lec 3, Lec 5, Lab 1-Lab 6 | 1, 2, 3, 4 |
| **PEK_K01 (competences)** | K2MIC_K05, K2MIC_K06 | C1, C2, C3 | Lec 1- Lec 6, Lab 1-Lab 5 | 1, 2, 3, 4 |
| **PEK_K02** | K2MIC_K03, K2MIC_K04 | C1, C2, C3 | Lec 1- Lec 6, Lab 1-Lab 5 | 1, 2, 3, 4 |

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above