FACULTY OF PURE AND APPLIED MATHEMATICS

SUBJECT CARD

Name in Polish: Zagadnienia ze swobodnym brzegiem
Name in English: Free boundary problems
Main field of study (if applicable): Applied Mathematics
Specialization (if applicable): Mathematics for industry and commerce
Profile: academic / practical*
Level and form of studies: 2nd* level, full-time /
Kind of subject: optional
Subject code
Group of courses YES

	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	60			
Form of crediting	crediting with grade				
For group of courses mark (X) final course	X				
Number of ECTS points	3	2			
including number of ECTS points for practical (P) classes	2	2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5	1,5			

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has basic knowledge and abilities in the area of ordinary and partial differential equations.

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SUBJECT OBJECTIVES

C1 Study of mathematical models of phenomena in science and technology leading to free boundary problems.
C2 Study of basic analytical methods in examining free boundary problems.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge: student
PEU_W01 knows basic mathematical models connected with free boundary problems.
PEU_W02 knows basic analytical methods in examining free boundary problems.

relating to skills: student
PEU_U01 can build mathematical models leading to free boundary problems.
PEU_U02 can examine free boundary problems.

relating to social competences: student
PEU_K01 is able to take benefits form scientific literature
PEU_K02 knows limitations of his knowledge and understands the need of further education.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Remaining basic theory of elliptic and parabolic partial differential equations.	2
Lec 2	Stefan problem, notion of the free boundary. Inverse Stefan problem.	2
Lec 3	Free boundary problems in melting and freezing. Modeling of problems connected with phase transition.	4
Lec 4	Modeling of flows in porous media: Boussinesq equation, porous media equation.	2
Lec 5	Self-similar solutions of porous media equation.	2
Lec 6	Free boundary in solutions of porous media equation, finite speed of propagation of disturbances. Retention and penetration property. Large time behavior of solutions.	2
Lec 7	Free boundary in reaction–diffusion–convection equations.	4
Lec 8	Diffusion in solids. Free boundary problems.	2
Lec 9	Modeling of flows in deformable media, spreading of impurities.	4
Lec 10	Free boundary problems in digital image processing.	2
Lec 11	Free boundary problems in financial mathematics.	2
Lec 12	Stationary free boundary problems: dam problem, obstacle problems in calculus of variations.	2
	Total hours	**30**

	Classes	**Number of hours**
Cl 1	Solving of problems illustrating theory given on lectures.	30
	Total hours	**30**

TEACHING TOOLS USED
N1. Lecture – traditional method. N2. Classes – traditional method.

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	PEU_W01 PEU_W02 PEU_K01	Final test
F2	PEU_U01 PEU_U02 PEU_K01 PEU_K02	Oral presentations, tests.
P= 0.5*F1+0.5*F2		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] R. M. Mattheij, S. W. Rienstra, J.H.M. ten Thije Boonkkamp, Partial Differential Equations, Modeling, Analysis, Computation, SIAM, Philadelphia 2005 [2] J. Ockendon, S. Howison, A. Lacey & A. Movchan, Applied Partial Differential Equations, Oxford University Press, Oxford 1999. [3] A. Fasano, Parabolic Free Boundary Problems in Industrial and Biological Applications, SIMAI e-Lecture Notes, Volume 9, 2011 **SECONDARY LITERATURE:** [1] V. Alexiades, A.D. Solomon, Mathematical Modeling of Melting and Freezing Processes, Hemisphere – Taylor & Francis, Washington, DC, USA, 1983 [2] J.L. Vazquez, The Porous Media Equation, Mathematical Theory, Clarendon Press, Oxford 2007 A.Friedman, Variational Principles and Free Boundary Problems, John Wiley and Sons, Inc
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr hab. Jan Goncerzewicz (Jan.Goncerzewicz@pwr.edu.pl)