DOCTORAL SCHOOL OF WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

SUPERVISOR/TEAM/ DECLARING/CONDUCTING COURSE: Henryk Kudela
DEPARTMENT: Faculty of Mechanical and Power Engineering W9
SCIENTIFIC DISCIPLINE: Environmental Engineering, Mining and Energy

COURSE CARD

Course name in Polish: Matematyczne wprowadzenie do mechaniki płynów
Course name in English: Mathematical introduction to fluid mechanics
Course language Polish / ~~English~~*
University-wide general course type*:
The course is intended for all PhD students: YES / NO
1) BASIC COURSE
~~2) SPECIALIST COURSE~~
~~3) SEMINAR~~
~~4) HUMANISTIC COURSE~~
~~5) LANGUAGE~~

Subject code: IGQ000001W

* delete as applicable

	Lecture	Foreign language course	Seminar	Mixed forms
Number of hours of organized classes in university (ZZU)	30			
Grading	Exam	Exam	Oral presentation	Exam, inspection, evaluation classes
Number of ECTS points	**0**			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Passed course on Mathematical Analysis II

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COURSE OBJECTIVES

C1 Passing of the fundamental knowledge of fluid mechanics with the theoretical and practical aspects with stress on mathematical description and formulation of the problem .

C2 Acquire of knowledge how formulate the law of mass, momentum and energy conservation for fluids

PROGRAM CONTENTS

Form of classes – lecture (Lec)		Number of hours
Lec1	Concept of continuum. Continuum hypothesis. Definition of motion. Description of motion in Lagrange variables and Euler's variables. Directional derivative.	2
Lec2	Reynolds transport theorem of. Acceleration in Euler and Lagrange variables.	2
Lec3	Euler theorem on differentiation of determinant-Principle of mass conservation. Continuity equation I Lagrange variables and Euler variable. Incompressible flow.	2
Lec4	Solving examples of differential equations that results from continuity equation Partial differential equation of first order. Burgers nonlinear equation	2
Lec5	Principle of momentum conservation. Tensors. Tensor of deformation. Cauchy first law of continuum motion.	2
Lec6	Conservation of moment of momentum. Cauchy second law for continuum mechanics. .	2
Lec7	Application of balance momentum. Drag force calculation for flow over the solid body.	2
Lec8	Theorem about transport of the kinetic energy.	2
Lec9	Equation of motion for non-viscous fluid. Vorticity transport theorem. Helmholtz decomposition theorem for vector fields.	2
Lec10	Bernoulli equation. Kelvin theorem - conservation of circulation	2
Lec11	Potential flows. Kinetic energy of potential flow- Thomson theorem. Laplace equation.	2
Lec12	Two dimensional potential flows. Stream function. Faction of complex variables. Complex potential. Example of applications	2
Lec13	Flow over the cylinder and it complex potential.The circle theorem.. Balsius theorem about forces acting on the body.. Kutta-Zukovsky formula	2
Lec14	Viscous flow. Stokes hypothesis about fluid. Navier-Stokes equation. Laminar flow in pipe. Reynolds experiment. Reunolds theorem about similarity of two flows.	2
Lec15	Remark on turbulence model. Deterministic chaos. Vortex flows and vorticity transport equation.	2
	Total hours:	**30**

TEACHING TOOLS USED

N1. Traditional lectures using multimedia presentation
N2. List problems for self-study
N3. Consultation
N4. Self-study – preparation for exams

ACHIEVED SUBJECT LEARNING OUTCOMES		
Type of learning outcome	Code of learning outcome	Assessment of learning outcome
Knowledge	P8S_WG	Student has a sound knowledge of basic subjects such as mathematics, physics, chemistry or others

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Henryk Kudela, Matematyczne wprowadzenie do mechaniki płynów, Oficyna Wydawicza PWr, 2016
[2] R. Gryboś, *Podstawy mechaniki płynów*, PWN 1989
[3] A. J. Chorin J.E. Marsden, *A mathematical introduction to fluid mechanics*, Springer-Verlag, 1990
[4] J. E. Marsden , A. Tromba, *Vector calculus*, Freeman, 2012
[5] F. M. White, *Fluid Mechanics*, McGraw-Hill, 1999

SECONDARY LITERATURE:

[6] J. Serrin, *Mathematical principles of classical fluid mechanics*, vol VIII/I , seria Encyclopedia of Physics, Fluid Dynamics I , ed. Flugge, Springer 1959.
[7] J. G. Currie, *Fundamentals Mechanics of Fluids*, Marcel Dekker, 2003
[8] D. J. Acheson, *Elementary fluid dynamics*, Clarendon Press, Oxford, 2005
[9] W. T. Shaw, *Complex Analysis with Mathematica*, Cambridge University Press, 2008.

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

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