8.17 CE0843 – Experimental Hydraulics

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	CIVIL ENGINEERING DEPARTMENT		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**CE0843**	**SEMESTER**	**8**
COURSE TITLE	**Experimental Hydraulics**		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
	2	3
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialization Course
PREREQUISITE COURSES:	Hydraulics (CE0520) Open Channel Hydraulics (CE0713) English level B2 or higher is required for Erasmus incoming students
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek (English/Erasmus)
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/CIV184/

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

Upon successful completion of the course, the student,

- will have understood the basic principles of dimensional analysis (dimensional homogeneity, Rayleigh method, PI Buckingham theorem),

- will have understood the principles governing the measurements of hydraulic quantities, issues of sampling and utilization of measurements for the construction of simple phenomenological / empirical models for the description of hydraulic phenomena by applying least squares methods,
- will have a realistic picture of the main hydraulic flow phenomena under pressure and with a free surface,
- will be familiar with taking hydraulic measurements with simple, reliable methods in an efficient manner,
- will be able to use and calibrate simple hydraulic devices for measuring or controlling flow / flow (manometric pipes, pipes of variable cross-section, overflows, re-scales, gates, etc.),
- be able to characterize flows with simple, practical methods,
- will be familiar with flow control,
- will be able to apply the acquired knowledge experience in research activity in the laboratory

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?;.

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Search for, analysis and synthesis of data and information, with the use of the necessary technology*
Adapting to new situations	*Adapting to new situations*
Decision-making	*Decision-making*
Working independently	*Working independently*
Team work	*Team work*
Working in an international environment	*Working in an international environment*
Working in an interdisciplinary environment	*Working in an interdisciplinary environment*
Production of new research ideas	*Production of new research ideas*

The course aims that the student acquires - practice the following general skills:

- Search for, analysis of, and synthesis of data and information, implementing appropriate technologies
- Independent work - Team work - Working in an international / interdisciplinary environment
- Delivery of new research ideas
- Project planning and management

(3) SYLLABUS

Theoretical part of the course

Introduction.
General about measurements. Organization of experimental research. Dimensional analysis. Homogeneity principle, Rayleigh method and P theorem.
Estimation of experimental errors. Edit experimental data.
Hydraulic similarity. Basic laws. Complete and partial similarity. Dummy construction. Scale effects.
Applications. Overview of techniques and instruments for measuring hydraulic quantities. Conducting experiments on flow problems in open and closed pipelines, vein diffusion, marine hydraulics and coastal engineering.

Laboratory part of the course.

Includes conducting the following laboratory exercises [analysis of each exercise with the basic theory, conducting an experiment, collecting and recording measurements, observations, preparation of written work (description of device and basic theoretical background, recording and processing of measurements, results and observations-conclusions):

Volumetric measurement, calibration of volumetric containers of simple geometric shapes
Volume supply measurement with weighing container - Use of hydraulic bank
Determination of hydrostatic force - pressure center on a submerged surface
Viscosity measurement by applying Stokes analysis for free sphere immersion
Flow transition from laminar to turbulent - Reynolds number
Venturi meter - flow analysis along the meter, laboratory meter calibration
Calibration & measurement of volumetric flow with various meters (Venturi, diaphragm, conical float)

Friction losses along a straight line
Imaginary flow line illustration - Hele-Shaw device
Liquid vein (jet) impact on surface
Supply and hydraulic energy measurements in a laboratory channel 1m.
Study of the flow through a barrier.
Flow study over wide / sharp crown overflows.
Study of flow in terraces, descents and around obstacles.
Wave transmission in free surface flow.
Study of the relationship between specific energy and flow depth. Critical flow.
Flow control with a combination of various hydraulic mechanisms.
Uniform, gradual and abruptly changing flow in a laboratory channel of 6m.
Calibration of extractors (triangular, rectangular, etc.).
Free surface flow velocity distribution (comparison of measurements and theoretical analysis predictions).
Hydraulic jump study. Phenomenology for different values of the Froude number.
Experimental determination of the roughness coefficient in a pipeline with cheeks of different roughness.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face in-class teaching. When needed, distance teaching (synchronous/asynchronous)
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of I.C.T. in Teaching, in Lab Practice and Student Communication
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS*	

Activity	***Semester workload***
In Class (/Distance) Teaching	26
Literature Study	30
Exercises / Paradigms	15
Project assignmenet / Essay	19
Course total	**90**

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open- ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	Language of evaluation: Greek (English/Erasmus) Written examination, 2,5-hours Problem solving, Multiple choice test, Questions and Answers, Written Essay / Project The evaluation criteria are announced to the students well before the examination; weights per subject /exercise are explicitly indicated. The examination results (including total / partial grading) are announced on the web. Students may require to have access to their tests, they may ask for clarifications on mistakes, grading etc.

(5) **ATTACHED BIBLIOGRAPHY**

Greek Bibliography:

1. Ι.Δ.Δημητρίου, Δ.Ι.Δημητρίου, ΠΕΙΡΑΜΑΤΙΚΗ ΥΔΡΑΥΛΙΚΗ ΚΑΙ ΥΔΡΑΥΛΙΚΕΣ ΜΕΤΡΗΣΕΙΣ, 2/2009, ISBN: 978960330683-2, Εκδ. Γ.Χ. ΦΟΥΝΤΑΣ, 2009
2. ΣΟΥΛΗΣ ΙΩΑΝΝΗΣ, ΜΕΤΡΗΣΕΙΣ ΥΔΡΑΥΛΙΚΗΣ ΜΗΧΑΝΙΚΗΣ, 1η εκδ. 2012, ISBN 978-960-549-002-7, Εκδ. Χ.Ν. ΑΪΒΑΖΗ, 2012
3. Κουσκούτη Μαρία Α.,Βλαχάκης Ν. Β., Εργαστήριο μηχανικής ρευστών και υδροδυναμικών - υδραυλικών εφαρμογών της, Εκδόσεις Πατάκη, 2004.

Foreign Bibliography:

1. Pawel Rowinski., Experimental Methods in Hydraulic Research [electronic resource: https://www.springer.com/gp/book/9783642174742], Springer, 2011.
2. Pawel Rowinski, Experimental and Computational Solutions of Hydraulic Problems [electronic resource: https://www.springer.com/gp/book/9783642302084], Springer, 2013