7.4 CE0713 – Hydraulics of Open Channels

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	CIVIL ENGINEERING DEPARTMENT		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**CE0713**	**SEMESTER**	**7**
COURSE TITLE	**Hydraulics of Open Channels**		

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**
	4	4
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:	Fluid Mechanics (CE0430) Hydraulics (CE0520)
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/CIV206/

(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 principles governing the flow of fluids with a free surface ("flow in open ducts")

will have understood the equations of mass and linear momentum, as applied to the modeling of one-dimensional flows in free surface conductors (St. Venant equations)

will be able to calculate basic hydraulic quantities (pressure, flow, static and dynamic pressure, total hydraulic energy, energy losses due to viscous friction, etc.) of typical one-dimensional free surface flow problems

will be able to apply the 3 basic balances (mass, energy, linear momentum) in solving different problems in free surface flows.

will have understood the phenomenology of free surface flows e.g. differences between slow and rapidly changing flows (SVF / RVF), hydraulic jumps, characteristic curves (falling, rising, etc.), and the categorization of the type of flows as a function of characteristic numbers e.g. Froude number (sub-critical flows) or Reynolds (laminar or turbulent flows)

will be able to design and dimension simple ducts for uniform flow with free surface

will be able to study and solve flow control problems in upgrades / descents, overflows, gates, change of pipe cross section, etc.

will be able to calculate the distribution of flow depth in conditions of permanent non-uniform flow along straight lines with or without abrupt change of inclination

be able to judge the operation of existing plumbing and propose improvement measures

will have acquired the necessary background knowledge for application in specialized flow problems in open pipelines of either technical sections (canals, canals) or natural sections (natural riverbed channels, ditches, rivers, etc.)

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
- Decision-taking
- Independent work - Team work - Working in an international / interdisciplinary environment
- Project planning and management
- Proact free, creative and inductive thinking

(3) **SYLLABUS**

Overview
• Differences between flow in "closed pipes" (flow under pressure) and flow in "open pipes" (flow with free surface).
• Smooth and turbulent flow in open pipes
• Velocity distribution
Differential equations of unstable flow in open conductors
• One-dimensional flow with free surface
• Equations St. Venant (continuity & motion)
• Empirical relationships (resistance grade - average velocity) Manning and Chezy
Examination of special flow cases
• Stable uneven flow, with and without lateral flow etc.
• Stable uniform flow and applications. Optimal cross sections. Complex cross sections.
Special action

• The specific energy - flow depth curve.
• Critical flow, analytical properties and applications
• Critical speed and wave transmission speed
• Froude number
• Flow analysis based on specific energy, flow type control constructs (critical, hypocritical, supercritical)
Uneven flow in open pipes of any cross section
• Overview and extension of flow equations to rectangular channels
Longitudinal sections (profiles / profiles) of the free surface of the water
• Qualitative analysis of the uneven flow equation, rise / fall curves
• Mild slope, M curves
• Steep slope, S curves
• Critical slope, C curves
• Horizontal bed, H curves
• Negative slope, curves A.
• Complex long surface free water profiles
Methods for calculating non-uniform flow
• Direct intergration
• Stepwise integration
Applications of linear momentum balances in one-dimensional flows with free surface
• General equations
• Study of hydraulic jump in channels of rectangular cross section
• Hydraulic jumps on inclined channels
• Hydraulic jumps in channels with abrupt change of cross section (descents, steps, section widening)

(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 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	52
Literature Study	38
Exercises / Paradigms	15
Project assignment / Essay	15
Course total	**120**

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 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 Bibliograpghy:

1. Τερζίδης Γεώργιος Α. Μαθήματα υδραυλικής, Τόμος 3, Εκδόσεις Ζήτη, 1985
2. Γ. ΝΟΥΤΣΟΠΟΥΛΟΣ, Γ. ΧΡΙΣΤΟΔΟΥΛΟΥ, ΤΗΛ. ΠΑΠΑΘΑΝΑΣΙΑΔΗΣ, ΥΔΡΑΥΛΙΚΗ ΑΝΟΙΚΤΩΝ ΑΓΩΓΩΝ, Εκδόσεις Φούντας, 2010
3. ΑΛΕΞΑΝΔΡΟΣ ΔΗΜΗΤΡΑΚΟΠΟΥΛΟΣ, ΣΤΟΙΧΕΙΑ ΥΔΡΑΥΛΙΚΗΣ ΚΛΕΙΣΤΩΝ ΚΑΙ ΑΝΟΙΚΤΩΝ ΑΓΩΓΩΝ, Εκδόσεις Γκότσης, 2018
4. Κατσιφαράκης Λ. Κωνσταντίνος, Μόνιμες ροές με ελεύθερη επιφάνεια, Εκδόσεις Κυριακίδη, 2017

Foreign Bibliography:

1. M. Hanif Chaudhry "Open-Channel Flow" [electronic resource: https://www.springer.com/gp/book/9780387301747], Springer, 2008
2. H.Chanson "The Hydraulics of Open Channel Flow: An Introduction Basic principles, sediment motion, hydraulic modelling, design of hydraulic structures" 2nd Ed. 2004, Elsevier
3. VenTe Chow "Open Channel Hydraulics" 1959 Mc Graw Hill