

## COURSE OUTLINE

### (1) GENERAL

|                                                                                                                                                                                                                                                                       |                                                                                                                             |                              |                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------|
| <b>SCHOOL</b>                                                                                                                                                                                                                                                         | UNIVERSITY OF THESSALY                                                                                                      |                              |                |
| <b>ACADEMIC UNIT</b>                                                                                                                                                                                                                                                  | DEPARTMENT OF CIVIL ENGINEERING                                                                                             |                              |                |
| <b>LEVEL OF STUDIES</b>                                                                                                                                                                                                                                               | UNDERGRADUATE                                                                                                               |                              |                |
| <b>COURSE CODE</b>                                                                                                                                                                                                                                                    | YΔ0610                                                                                                                      | <b>SEMESTER</b>              | 9              |
| <b>COURSE TITLE</b>                                                                                                                                                                                                                                                   | MANAGEMENT OF EXTREME HYDROLOGICAL PHENOMENA                                                                                |                              |                |
| <b>INDEPENDENT TEACHING ACTIVITIES</b><br><i>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</i> |                                                                                                                             | <b>WEEKLY TEACHING HOURS</b> | <b>CREDITS</b> |
|                                                                                                                                                                                                                                                                       |                                                                                                                             | 4                            | 6              |
|                                                                                                                                                                                                                                                                       |                                                                                                                             |                              |                |
|                                                                                                                                                                                                                                                                       |                                                                                                                             |                              |                |
| <i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).</i>                                                                                                                                              |                                                                                                                             |                              |                |
| <b>COURSE TYPE</b><br><i>general background, special background, specialized general knowledge, skills development</i>                                                                                                                                                | Specialized general knowledge, skills development                                                                           |                              |                |
| <b>PREREQUISITE COURSES:</b>                                                                                                                                                                                                                                          |                                                                                                                             |                              |                |
| <b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>                                                                                                                                                                                                                      | Greek.<br>If there are ERASMUS students, material is given in English, and the subjects/exams of the course are in English. |                              |                |
| <b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>                                                                                                                                                                                                                      | YES                                                                                                                         |                              |                |
| <b>COURSE WEBSITE (URL)</b>                                                                                                                                                                                                                                           | <a href="https://eclass.uth.gr/courses/CULT_U_140/">https://eclass.uth.gr/courses/CULT_U_140/</a>                           |                              |                |

### (2) LEARNING OUTCOMES

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| <b>Learning outcomes</b><br><i>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.</i><br><i>Consult Appendix A</i> <ul style="list-style-type: none"> <li>• Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</li> <li>• Descriptors for Levels 6, 7 &amp; 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</li> <li>• Guidelines for writing Learning Outcomes</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>Scope of the course is the introduction to hydrology of floods and droughts and natural and human-induced causes of floods and droughts, methods and models of flood and drought analysis and flood and drought management. The outline of the course includes: Introduction to droughts (Definitions, types, characteristics). Climatological and human-induced causes and predictability. Types of droughts (meteorological, hydrological (low flow river and groundwater drought), agricultural and water resources drought). Methods and models of analysis. Drought Indices. Drought modeling using meteorological, agrohydrological and hydrological models. Stochastic modeling of droughts. Probabilistic modeling of droughts. Introduction on hydrology of floods (flood types, characteristics and causes of flooding). Statistical Frequency Analysis of Hydrologic Data. Regional Frequency analysis. Flood Mapping and Flood Zoning. Flash Floods. Urban Floods. Climate Change and Floods. Drought and flood management (adaptation and mitigation, preparedness plans).</p> <p>This course strengthens students' technical and intellectual competency, preparing them for engineering employment or advanced study. The course exposes students to computational techniques of flood risk estimation and drought identification, modelling, monitoring and assessment used in modern professional and engineering practice. Upon completion of the course, students should be able to demonstrate:</p> |

- Understanding of drought types and their characteristics
- Understanding drought causes and impacts of drought
- Understanding the benefits and limitations of different approaches used in drought modelling (statistical, stochastic-probabilistic methods etc.)
- To employ various drought techniques (meteorological and hydrological) for drought modelling and monitoring
- Understanding of the natural processes of flood generation
- Understanding and practical familiarity with current modelling and statistical approaches to flood risk estimation and modelling
- Understanding the range of different approaches used in flood modelling
- Ability to estimate the design flood of a watershed with statistical analysis of flow data or application of empirical methods and hydrological models
- Ability to apply current methods for flood risk estimation in basic cases

#### *Skills*

Upon completion of the course, the student possesses advanced skills in processing, analyzing and solving complex problems in the science of hydraulic engineering related to:

- Flood Management
- Drought Management

#### *Abilities*

After completing the course, the student manages complex flood work projects and can make decisions on flood/drought design, simulation and management. He is also able to work individually and as a team when designing, managing and modelling such phenomena. Especially students will be able to:

- evaluate and judge technical and environmental factors in hydrological hazard planning, modelling and management process and
- synthesize and propose optimal or new solutions based on the above evaluation.

#### **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?*

|                                                                                                             |                                                                                                 |
|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| <i>Search for, analysis and synthesis of data and information, with the use of the necessary technology</i> | <i>Project planning and management</i>                                                          |
| <i>Adapting to new situations</i>                                                                           | <i>Respect for difference and multiculturalism</i>                                              |
| <i>Decision-making</i>                                                                                      | <i>Respect for the natural environment</i>                                                      |
| <i>Working independently</i>                                                                                | <i>Showing social, professional and ethical responsibility and sensitivity to gender issues</i> |
| <i>Team work</i>                                                                                            | <i>Criticism and self-criticism</i>                                                             |
| <i>Working in an international environment</i>                                                              | <i>Production of free, creative and inductive thinking</i>                                      |
| <i>Working in an interdisciplinary environment</i>                                                          | <i>.....</i>                                                                                    |
| <i>Production of new research ideas</i>                                                                     | <i>Others...</i>                                                                                |
|                                                                                                             | <i>.....</i>                                                                                    |

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Adapting to new situations
- Decision-making
- Working independently
- Team work on Labs
- Working in an interdisciplinary environment
- Project planning and management
- Production of free, creative and inductive thinking
- Respect for the natural environment
- Showing social, professional and ethical responsibility

### **(3) SYLLABUS**

1. Introduction to floods (flood types, characteristics and causes of floods).

2. Statistical frequency analysis of hydrologic data. Design flood considerations.
3. Analysis of hydrological processes, rainfall-runoff modelling, effective precipitation, flood hydrographs.
4. Rainfall-runoff mechanism modeling: categories of hydrological models.
5. Flood simulation using rainfall-runoff hydrological models.
6. Flood routing: hydrological and hydraulic methods of flood routing. Hydrological and hydraulic flood modelling using open source software. Examples and applications.
7. Floods and sediments: properties of sediment materials. Initiation of material movement: critical flow velocity, critical shear stress. Bed formations. Bed load transport theory. Transport of suspended solids: diffusion theory, steric distribution equations of suspended solids Total bed load transfer: total steric distribution equations. Bridge scouring, Mass transport models: scales in physical models. Numerical examples.
8. Flood protection works: riverine flood works, works in the mountainous part of the catchment. Analysis and evaluation of technical flood protection projects through simulation. Analysis and simulation of natural flood management solutions.
9. Bridge scour: Long-term degradation, contraction scour, local scour
10. Flood protection works
11. Introduction to droughts (Definitions, types, characteristics).
12. Meteorological and agricultural drought. Drought Indices.
13. Hydrological (low flow river and groundwater drought) and water resources drought. Drought Indices.
14. Management of Extreme Hydrological Phenomena: The 4Ms: Modelling, Monitoring, Management and Mitigation. Early Warning Systems

#### (4) TEACHING and LEARNING METHODS - EVALUATION

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| <b>DELIVERY</b><br><i>Face-to-face, Distance learning, etc.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                           | Face-to-face                                                              |                          |  |
| <b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b><br><i>Use of ICT in teaching, laboratory education, communication with students</i>                                                                                                                                                                                                                                                                                                                                                               | Lectures with PowerPoint<br>Notes, Exercises and Announcements in e-class |                          |  |
| <b>TEACHING METHODS</b><br><i>The manner and methods of teaching are described in detail.<br/>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.<br/><br/>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</i> | <i>Activity</i>                                                           | <i>Semester workload</i> |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Lectures                                                                  | 14 * 4 = 56 hours        |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Project                                                                   | 64 hours                 |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Study                                                                     | 40 hours                 |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                           |                          |  |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Course total</b>                                                       | <b>160</b>               |  |

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| <p><b>STUDENT PERFORMANCE EVALUATION</b></p> <p><b>Description of the evaluation procedure</b></p> <p><i>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</i></p> <p><i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i></p> | <p><b>Language of Evaluation:</b><br/>Greek (English for Erasmus students)</p> <p><b>Teaching method:</b> The lectures of the course are combined with corresponding individual and/or group laboratory exercises and applications on which a significant part of the assessment is based. At the same time, comprehensive semester projects are prepared, with specific examples in which emphasis is placed on the utilization of the methods and analysis techniques presented.</p> <p><b>Teaching Rationale:</b> To impart the basic theoretical and practical understanding represented by the knowledge and skills outcomes via a mix of self-learning and formal teaching, including formal lectures and practicals in the lab sessions with active student participation. Lectures introduce theory and concepts, which are then exemplified in computer workshops using specialist packages and tailored data sets. For modelling of extreme hydrological phenomena, the theory underpinning modern practice is taught in lectures and then tested in practical lab sessions.</p> <p><b>Evaluation method:</b><br/><u>100% Project:</u> Integrated example of modelling of extreme hydrological phenomena. Compulsory delivery of project. Technical Report. Oral examination: presentation of the project.</p> <p><b>Evaluation Rationale:</b> A substantial piece of coursework will test the students' ability to understand and apply the knowledge they acquire in practice at the lab sessions, including the use of methods and software. In addition, as it is an open-ended work it also tests students' initiative. Assessment will be 100% coursework. A headstart will be made using computational resources during the lab sessions, with further analysis and writing up afterwards.</p> |
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## (5) ATTACHED BIBLIOGRAPHY

### **-Suggested bibliography:**

#### *Greek Bibliography*

- Δερμίσης, Β., 2010. «Διευθετήσεις Υδατορρευμάτων», 1<sup>η</sup> Έκδοση, Εκδόσεις Τζιόλα, ISBN: 978-960-418-296-1.
- Κουτσογιάννης, Δ., 1997. «Στατιστική Υδρολογία» [ηλεκτρ. βιβλ.] Αθήνα:Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών (<http://hdl.handle.net/11419/5889>).
- Κουτσογιάννης, Δ., Ξανθόπουλος, Θ., 1999. «Τεχνική Υδρολογία» [ηλεκτρ. βιβλ.] Αθήνα:Σύνδεσμος Ελληνικών Ακαδημαϊκών Βιβλιοθηκών (<http://hdl.handle.net/11419/5888>).
- Μιμίκου, Μ., 2006. «Τεχνολογία Υδατικών Πόρων», 3<sup>η</sup> Έκδοση, Εκδόσεις Α. ΠΑΠΑΣΩΤΗΡΙΟΥ & ΣΙΑ Ι.Κ.Ε., ISBN: 978-960-7530-79-0.
- Τσακίρης, Γ., 2012. «Υδατικοί Πόροι Ι. Τεχνική Υδρολογία», Εκδόσεις Συμμετρία, ISBN: 978-960-266-380-6.
- Τσόγκας, Χ., και Ε. Τσόγκα, 2009. «Υδροδυναμικά Έργα – Φράγματα», 2<sup>η</sup> Έκδοση, Εκδόσεις Ίων, ISBN: 960-411-196-5.

#### *English Bibliography*

- Anderson, M.G., and J.J. McDonnell (eds.), 2005. Encyclopedia of Hydrological Sciences, Wiley Publications.
- Beven, K.J., 2012. Rainfall-Runoff Modelling: The Primer, 2nd Edition, Wiley-Blackwell.
- Ghosh, S.N., 2014. Flood Control and Drainage Engineering, 4<sup>th</sup> Edition, CRC Press.
- Karamouz, M., Nazif, S., Falahi, M., 2013. Hydrology and Hydroclimatology: Principles and Applications. CRC Press.

Maidment, D.R., (ed.), 1993. Handbook of Hydrology. McGraw-Hill.

Mays, L.W., 2010. Water Resources Engineering, 2<sup>nd</sup> Edition, John Wiley & Sons.

Mimikou, M., Baltas, E. and Tsihrintzis, V., 2016. Hydrology and Water Resources System Analysis, July 2016, Textbook – 448 Pages – 208 B/W Illustrations, ISBN 9781466581302, CRC Press, Taylor and Francis Group.

Novak, P, Moffat, Al.B., Nalluri, C., Narayanan, R. 1996, «Hydraulic Structures», E & FN Spon, 2<sup>nd</sup> Ed.

Ramachandra Rao, A., K.H. Hamed, 2000. Flood Frequency Analysis, CRC Press.

Rossi G., T. Vega, and B. Bonaccorso, (eds.) (2007). Methods and Tools for Drought Analysis and Managment. Water Science and Technology Library, Vol. 62, Springer Publications.

Sene, K., 2008. Flood Warning, Forecasting and Emergency Response, Springer Publications.

Smith, K, Ward, R., 1998. Floods: Physical processes and Human Impacts, J. Wiley.

Tallaksen L.M., and H.A.J. van Lanen, (eds.) (2004). Hydrological Drought - Processes and Estimation Methods for Streamflow and Groundwater, Developments in Water Sciences 48, Elsevier B.V., The Netherlands.

Vischer, O.I., Hager, W.H., 1998. Dam Hydraulics, J. Wiley.

Watt, W.E. et al., 1989. Hydrology of Floods in Canada: A Guide to Planning and Design. NRCC.

World Meteorological Organization, (WMO) (2008). Manual on Low-flow Estimation and Prediction. WMO- No. 1029, Operational Hydrology report No. 50, 136p.

**- Related academic journals:**

Advances in Water Resources, Journal of Hydrology, Hydrological Processes, Water, Hydrology, Hydrological Sciences Journal, International Journal of Water Resources Development, Water Resources Management, River Research and Application, Water Resources Research, Journal of Flood Risk Management, Journal of the American Water Resources Association, Wiley Interdisciplinary Reviews: Water, Journal of Hydraulic Engineering, Journal of Irrigation and Drainage Engineering, Journal of Hydrologic Engineering, Journal of Water Resources Planning and Management, Hydrology and Earth System Sciences, Natural Hazards and Earth System Sciences, Advances in Geosciences, ICOLD Congresses Proceedings, Dams and Reservoirs, International Journal on Hydropower & Dams.