**COURSE OUTLINE**

1. **GENERAL**

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| **SCHOOL** | SCHOOL OF ENGINEERING |
| **ACADEMIC UNIT** | DEPARTMENT OF CIVIL ENGINEERING  |
|  | UNIVERSITY OF PATRAS |
| **POSTGRADUATE PROGRAM: TITLE** | Master’s Degree "Design of Resilient, Sustainable and Intelligent Infrastructures". Tracks:(A) Resilient Materials, Structures and Geotechnical Infrastructures,(B) Hydraulic and Environmental Engineering for Sustainable Infrastructures, and (C) Intelligent Systems in Transportation and Construction Project Management  |
| **LEVEL OF STUDIES** | POSTGRADUATE PROGRAM |
| **COURSE CODE** | CIV1825 | **SEMESTER** | SPRING (B’) |
| **COURSE TITLE** | Statistical analysis and modeling of extreme values for hydrologic applications |
| **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** |
|  | 3 | 7.5 |
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| *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* | Special background (elective) |
| **PREREQUISITE COURSES:** | Risk and Reliability Analysis for Infrastructures |
| **LANGUAGE OF INSTRUCTION and EXAMINATIONS:** | Greek |
| **IS THE COURSE OFFERED TO ERASMUS STUDENTS** |  |
| **COURSE WEBSITE (URL)** | https://eclass.upatras.gr/courses/CIV1825/ |

1. **LEARNING OUTCOMES**

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| **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*
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| The postgraduate student familiarizes with the use tools from probability theory, to analyze and model extreme events for hydrological applications. |
| **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* *Adapting to new situations* *Decision-making* *Working independently* *Team work**Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*  | *Project planning and management* *Respect for difference and multiculturalism* *Respect for the natural environment* *Showing social, professional and ethical responsibility and sensitivity to gender issues* *Criticism and self-criticism* *Production of free, creative and inductive thinking**……**Others…**…….* |
| * Search for, analysis and synthesis of data and information, with the use of the necessary technology
* Working independently
* Working in an interdisciplinary environment
* Decision making
* Production of new research ideas
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1. **SYLLABUS**

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| 1. **Setting the stage**
	1. Extremes: low frequencies vs extreme consequences
	2. Functions of random vectors: the case of min/max functions
	3. Engineers’ approach to extremes: The return period concept and alternative definitions
2. **Univariate extremes**
	1. Introduction to extreme value theory and models
		1. Extreme value theorem and max-stability: assumptions and limitations
		2. The generalized extreme value (GEV) distribution
		3. Distribution fitting
			1. Method of moments
			2. Method of maximum likelihood
			3. Method of probability weighted moments
		4. Estimation of return levels from data: Construction of intensity-duration-frequency (IDF) curves from annual rainfall maxima
	2. Introduction to extreme excess theory and threshold models
		1. Extreme excess theorem: assumptions and limitations
		2. The generalized Pareto (GP) distribution: assumptions and limitations
		3. Threshold detection
		4. Distribution fitting
			1. Method of moments
			2. Method of maximum likelihood
			3. Method of probability weighted moments
		5. Estimation of return levels from data: Construction of intensity-duration-frequency (IDF) curves from peaks-over-threshold (PoT) series
3. **Multivariate extremes**
	1. Multivariate extreme value distributions and max-stability
	2. Max-stable models and extreme value copulas
	3. Fitting extreme value copulas to data
4. **Extremes of dependent realizations**
	1. Asymptotic convergence and its dependence on the observation scale: Extreme value theory vs Large-deviation theory
	2. Relaxation of the independence assumption under pre-asymptotic conditions and approximate convergence
	3. Stationary stochastic self-similar (sss, or multifractal) processes
		1. Properties and generation
		2. The beta-lognormal discrete multifractal model
		3. Parameter estimation
	4. Estimation of return levels from data: Construction of intensity-duration-frequency (IDF) curves from short rainfall records (e.g. 1-2 years of data).
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1. **TEACHING and LEARNING METHODS - EVALUATION**

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| **DELIVERY***Face-to-face, Distance learning, etc.* | Face-to-face class lectures and problem solving |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** *Use of ICT in teaching, laboratory education, communication with students* | Distribution of academic material through e-class. |
| **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* |

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| ***Activity*** | ***Semester workload*** |
| Class lectures and problem solving recitation sessions. | 39 |
| Independent study | 149 |
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| *Course total*  | ***188*** |

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| **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.* | * Problem sets
* Final written examination
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1. **ATTACHED BIBLIOGRAPHY**

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| Beirlant, J., Y. Goegebeur, J. Segers and J. L. Teugels (2004) *Statistics of Extremes - Theory and Applications*, Wiley Series in Probability and Statistics.Coles, S. (2001) *An introduction to statistical modeling of extreme values*, Springer-Verlag, London.de Haan, L. and A. Ferreira (2006) *Extreme Value Theory: An Introduction*, Springer.Gudendorf, G. and J. Segers (2010) Extreme-Value Copulas, In: *Copula Theory and Its Applications,* Proceedings of the Workshop Held in Warsaw, 25-26 September 2009, Eds. P. Jaworski, F. Durante, W. Härdle, and T. Rychlik, Lecture Notes in Statistics – Proceedings, 198, Springer.Hosking, J.R.M. and R. Wallis (1997) *Regional frequency analysis: An approach based on L-moments*, Cambridge University Press, Cambridge, U.K.Langousis, Α. (2021) *Introduction to Statistical Analysis and Modeling of Extreme Values for Engineering Applications*, Department of Civil Engineering, University of Patras, Greece, 105 pages.Veneziano D. and A. Langousis (2010) Scaling and Fractals in Hydrology, In: Advances in Data-based Approaches for Hydrologic Modeling and Forecasting, Eds. B. Sivakumar and R. Berndtsson, World Scientific, 145p. |