**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** | **GPOL\_R\_16102** | **SEMESTER** | Autumn (A’) |
| **COURSE TITLE** | Design principles for resilient, sustainable, and smart infrastructures |
| **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** |
| Lectures | 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* | Specialised general knowledge |
| **PREREQUISITE COURSES:** |  |
| **LANGUAGE OF INSTRUCTION and EXAMINATIONS:** | Greek |
| **IS THE COURSE OFFERED TO ERASMUS STUDENTS** | No |
| **COURSE WEBSITE (URL)** | https://eclass.upatras.gr/courses/CIV1827/ |

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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| Desired learning outcomes:* Familiarization with the notion of resilience
* Use probability theory to build fragility curves
* Design for resilience
* Connection between climate variability, greenhouse gas emissions scenarios and environmental loads.
* Assessment methods of infrastructure vulnerability, sustainability and resilience.
* Transportation system disruption and emergency recovery management.
* Artificial intelligence / machine learning in construction and infrastructure management.
* Digital solutions for smart interconnected infrastructures.

Specific knowledge and competences:* Determination of fragility curves
* Use of innovative technologies to achieve resilience
* Determination of assessment indices of infrastructure vulnerability.
* Determination of parameters in methods of infrastructure resilience and sustainability assessment.
* Evaluation of transport operation recovery solutions following incidents and emergencies.
* Engineering problem solving using machine learning tools.
* Application design for smart interconnected infrastructures.
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| **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
* Decision making
* Working independently
* Working in an interdisciplinary environment
* Project planning and management
* Respect for the natural environment
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1. **SYLLABUS**

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| * Definition of the notion of resilience
* Basic methods to assess resilience at component, system, system-of-systems and network level
* Design for resilience
* Resilience-enabling technologies - code provisions
* Climate variability: terminology, greenhouse gas emissions scenarios, climate models.
* Environmental hazards (earthquake, flood, fire, erosion): identification, characterization.
* Principles of sustainability and resilience in the infrastructure design and management: terminology, indices and assessment systems of infrastructure sustainability, methods of infrastructure resilience assessment, indicative examples (water basins, dams, flood protection works, water distribution networks, rainwater and wastewater networks, water treatment systems, wastewater treatment and reuse systems, protection and restoration of water ecosystems, coastal breakwaters, port quay walls).
* Resilience of transportation systems, disruptions due to events and emergencies, measurement of demand and network capacity in real time, evaluation of response scenarios and optimization of traffic redistribution in the network.
* Artificial intelligence / machine learning applications in civil engineering disciplines and in project and infrastructure management.
* Tools and technologies for the development of smart interconnected infrastructures.
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1. **TEACHING and LEARNING METHODS - EVALUATION**

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| **DELIVERY***Face-to-face, Distance learning, etc.* | Face to face |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** *Use of ICT in teaching, laboratory education, communication with students* | Open access software tools & platformsSupport of the learning process using the e-class platform |
| **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*** |
| Lectures (3 hours per week) | 39 |
| Home study - literature search and review | 90 |
| Homework | 42 |
| Final exam preparation | 16,5 |
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| *Course total*  | *187,5* |

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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.* | Based on1. Homework (75%)
2. Final exam (25%)
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1. **ATTACHED BIBLIOGRAPHY**

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| --- |
| *- Suggested bibliography:*1. FEMA P58 - Performance estimation Tool
2. Rosti, Α., Del Gaudio, C., Rota, M., Ricci, P., Di Ludovico, M., Penna, A., Verderame, G. M. (2020) Empirical fragility curves for Italian residential RC buildings, Bulletin of Earthquake Engineering, 19:3165–3183 https://doi.org/10.1007/s10518-020-00971-4
3. SYNER-G project: reports on fragility curves for reinforced concrete an masonry buildings, for gas and oil system networks, water/waste water elements, for harbor elements - Application to city level. http://www.vce.at/SYNER-G/files/dissemination/deliverables.html
4. FEMA HAZUS Programme, https://www.fema.gov/hazus/, https://msc.fema.gov/portal/resources/hazus
5. Arup, "The Resilience-based Earthquake Design Initiative (REDI) Rating System", https://www.arup.com/perspectives/publications/research/section/redi-rating-system
6. ASCE (2021). Hazard-Resilient Infrastructure: Analysis and design. Ed. Bilal M. Ayyub, Ph.D., P.E., American Society of Civil Engineers, Reston, Virginia.
7. Hammond, A., Adriaanse, A., Rodenburg, E., Bryant, D., and Woodward, R. (1995). Environmental indicators: a systematic approach to measuring and reporting on environmental policy performance in the context of sustainable development. World Resources Institute.
8. IPCC (2000). Emissions Scenarios – Summary for Policy Makers. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change, WMO and UNEP.
9. FHWA (2020). Emergency Transportation Operations Preparedness, <https://ops.fhwa.dot.gov/eto_tim_pse/preparedness/eto/index.htm>.

Deka, P.C. (2019). A Primer on Machine Learning Applications in Civil Engineering, Taylor & Francis Group.  |