**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** | A16012 | | **SEMESTER** | AUTUMN (A’) |
| **COURSE TITLE** | Design of Steel Structures for Robustness and Resilience against Extreme Hazards | | | | |
| **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 | | | | |
| **PREREQUISITE COURSES:** | none | | | | |
| **LANGUAGE OF INSTRUCTION and EXAMINATIONS:** | Greek unless we have a student from abroad (e.g. erasmus) | | | | |
| **IS THE COURSE OFFERED TO ERASMUS STUDENTS** | yes | | | | |
| **COURSE WEBSITE (URL)** | http://www.civil.upatras.gr/en/MetaptixiakhEkpaideysh/Mathimata/EidikeusiA/entry/9ae6484b-48b1-4a3c-b388-7de5fcbd6bbb/?PageNo=0 | | | | |

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* | |
| After successful completion of the course the student will have a solid theoretical background and practical knowledge in:  • Nonlinear behaviour of steel under monotonic and cyclic loading  • Nonlinear behaviour of steel structural components  • Local buckling of thin steel plates  • Methods for the simulation of the response of steel structures under extreme loads  • Seismic design of steel structures  • Design of steel structures against progressive collapse  • Modern technologies for resilience-based design of steel structures | |
| **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…*  *…….* |
| Working independently  Criticism and self-criticism  Decision-making  Adapting to new situations | |

1. **SYLLABUS**

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| •Mechanical properties of structural steel. Yielding mechanism and hardening. Brittle and ductile fracture. High-cycle and low-cycle fatigue. Fracture prediction criteria for steel structural components under three-dimensional monotonic and cyclic loading.  •Geometric and material nonlinearities in steel frames. P-Δ and P-δ effects. Lateral-torsional buckling and conventional/geometric stiffness matrices of 14 degrees-of-freedom. Lumped and distributed plasticity. Local inelastic buckling and its effect on the monotonic and hysteretic behaviour of steel structural members. Nonlinear static and dynamic analysis of steel frames. Open source software in MATLAB. The software OpenSees. The software SAP2000.  •Introduction to Eurocode 8. Methods of analysis for buildings. Design criteria for buildings. Design criteria for seismic-resistant steel frames.  •Steel moment resisting frames. Design criteria in EC8. Design criteria in AISC. Structural details for ductile behaviour. Modelling for nonlinear dynamic analysis under seismic excitations.  •Steel concentric braced frames. Design criteria in EC8. Design criteria in AISC. Structural details for ductile behaviour. Modelling for nonlinear dynamic analysis under seismic excitations.  •Steel eccentric braced frames. Design criteria in EC8. Design criteria in AISC. Structural details for ductile behaviour. Modelling for nonlinear dynamic analysis under seismic excitations.  •Design of steel frames for low-damage seismic performance and resilience. Steel frames with buckling restrained braces or other metallic energy dissipation devices. Structural details. Modelling for nonlinear dynamic analysis under seismic excitations.  •Steel frames with viscous or viscoelastic dampers. Structural details. Modelling for nonlinear dynamic analysis under seismic excitations.  •Steel post-tensioned self-centering moment-resisting frames. Structural details. Modelling for nonlinear dynamic analysis under seismic excitations.  •Design of steel structures for robustness against extreme man-made hazards. The extreme scenario of sudden column loss due to blast or impact. Design guidelines against progressive collapse in Eurocode 1 (Part 1-7). Design guidelines for robustness and progressive collapse resistance in the UK. Design guidelines in the USA.  •Robustness of steel connections and joints. Behaviour of nominally pinned, partial-strength, and full-strength end plate beam-column connections under a loss of column scenario. Application of the component method of EC3 (Part 1-8) for the calculation of the rotational capacity of end plate connections under the influence of large tensile axial forces. Design recommendations for large rotational capacity.  •Simulation of the dynamic response of steel buildings to sudden column loss. Appropriate nonlinear models for beams, columns, joints, composite beams, and composite slabs. |

1. **TEACHING and LEARNING METHODS - EVALUATION**

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| **DELIVERY** *Face-to-face, Distance learning, etc.* | Face-to-face, Distance learning during the pandemic period |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** *Use of ICT in teaching, laboratory education, communication with students* | Use of software for nonlinear structural analysis |
| **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*** | | Lectures | 50 | | Study | 137.5 | |  |  | |  |  | |  |  | |  |  | |  |  | |  |  | |  |  | | *Course total* | ***187.5*** | |
| **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.* | Coursework and 15 minutes oral presentation |

1. **ATTACHED BIBLIOGRAPHY**

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| *- Suggested bibliography:*   * Matrix Structural Analysis (chapters on geometric and material nonlinearity). McGuire W, Gallagher R, Ziemian R * Ductile Design of Steel Structures. Bruneau M, Uang C-M, Sabelli R |