**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** | \*\*\*\* | **SEMESTER** | | AUTUMN (A’) | |
| **COURSE TITLE** | Soil Dynamics and Seismic Design of Foundations | | | | |
| **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 and Tutorials | | | 3 | | 7.5 |
|  | | |  | |  |
| *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:** | There are no prerequisite courses. It is anticipated, however, that students should have background of Soil Mechanics | | | | |
| **LANGUAGE OF INSTRUCTION and EXAMINATIONS:** | Greek. | | | | |
| **IS THE COURSE OFFERED TO ERASMUS STUDENTS** | Yes | | | | |
| **COURSE WEBSITE (URL)** | \*\*\* new web site \*\*\* | | | | |

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* | |
| At the end of this course the students will be able to:   1. Identify the types of dynamic loading that can act on a soil element. 2. Understand the steps involved in solving problems with dynamic soil loading, including the analysis and design of different categories of geotechnical works. 3. Use concepts from the theory of vibration of single– and multi-degree of freedom systems. 4. Understand and use concepts related to stress wave propagation in homogeneous and inhomogeneous soils. 5. Know and understand the available methods (field, laboratory, indirect) for evaluating the dynamic soil properties. 6. Use analytical models for describing the dynamic behavior of soil (linear, equivalent linear, non-linear inelastic). 7. Analyse and calculate the dynamic response of rigid shallow foundations under man-made vibrations. 8. Know and understand the principles behind the available isolation methods against ground-borne man-made vibration and the capabilities of each method. 9. Select permissible values of soil vibrations to assure the normal operation and safety of geotechnical systems. | |
| **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   * Production of new research ideas | |

1. **SYLLABUS**

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| **1. INTRODUCTION**  Definition of dynamic soil loading, types of dynamic soil loadings, special characteristics of dynamic soil loadings, methodology for analyzing and designing geotechnical systems under dynamic loading  **2. ELEMENTS OF THEORY OF VIBRATION**  Time-dependent motion of soil element, mathematical description, non-periodic, periodic and harmonic motion. Fourier Analysis. The single degree of freedom system, natured frequency, damping, free and forced vibrations. Measurement of vibrations, resonance tests. Two degree of freedom systems, coupled vibrations  **3. WAVE PROPAGATION IN SOILS**  The wave concept, wave propagation in homogeneous elastic half-space, longitudinal and shear body waves, surface waves (Rayleigh and Love), wave length, natural frequencies and normal modes of vibration of soil systems. Layered half-space, reflection and refraction of waves at soil interfaces, wave propagation in porous soil media, effect of water table.  **4. EVALUATION OF DYNAMIC SOIL PROPERTIES**  Field methods (Direct wave propagation, wave reflection and refraction methods, surface wave methods-SASW, MASW , Cross-hole method). Laboratory methods (Resonant column method, cyclic triaxial, simple shear and torsional hollow cylinder test methods) Indirect methods (Hardin equation, correlations with NSPT, CPT and shear strength, τmax )  **5. DYNAMIC BEHAVIOR OF SOIL ELEMENT**  Identification of shear modulus and damping ratio as the most important dynamic soil properties. The effects of: confining stresses, duration of loading, void ratio, amplitude of vibration, number of cycles of loading and loading history on modulus and damping. Analytical models of Hardin-Drnevich and Ramberg-Osgood for describing the stress-strain behavior of soil element.  **6. VIBRATIONS OF SHALLOW RIGID FOUNDATIONS**  Identification of the six degrees of freedom of a rigid foundation. Evaluation of equivalent spring constants, vertical and horizontal vibrations, coupled horizontal and rocking vibrations, torsional vibrations in homogeneous and layered half-space.  **7. ISOLATION AGAINST GROUND VIBRATIONS**  Methods for isolation of man-made ground vibrations. Use of soil trenches, pile-rows and wave impedance (WIB) techniques. Active and passive isolation. Isolation efficiency  **8. FAILURE CRITERIA**  Review of available failure criteria and permissible values of vibration (displacement, velocity, acceleration) for different categories of structures and processes. |

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

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| **DELIVERY** *Face-to-face, Distance learning, etc.* |  |
| **USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY** *Use of ICT in teaching, laboratory education, communication with students* |  |
| **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 & Tutorials | 39 | | Placements | 100 | | Hours for private study | 48.5 | |  |  | |  |  | |  |  | |  |  | |  |  | |  |  | | *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.* | 1. Written exams which include problem solving (50%)  2. Evaluation of Team work Project (30%) |

1. **ATTACHED BIBLIOGRAPHY**

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| *- Suggested bibliography:*   1. Das, B. M. and Ramana, G. V. (2010), “Principles of Soil Dynamics”, Cengage Learning, Stamford, CT 06902 2. Semblat, J. F. and Pecker, a. (2009), “Waves and Vibrations in Soils: Earthquakes, Traffic, Shocks, Cosntruction Works” IUSS Press, 2009 3. Verruit, A. (2010), “An Introduction to Soil Dynamics”. Springer, 2010 4. Santamarina, J.C. (2001), “Soil and Waves”, John Wiley & Sons, England, 2001 5. Wolf, J.P. and Deeks, A.J. (2004), “Foundation Vibration Analysis: A Strength – of- Materials Approach”, Elsevior, 2004 |