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Strengthening Educational Capacities by Building Competences and Cooperation in the Field of Noise and Vibration Engineering

S E N V I B E

Report on Design of New Courses

Activity 3.2

Date: 31/05/2020

Content:

1. Introduction

The project SENVIBE 'Strengthening Educational Capacities by Building Competences and Cooperation in the Field of Noise and Vibration Engineering' (598241-EPP-1-2018-1-RS-EPPKA2-CBHE-JP):

https://senvibe.uns.ac.rs/

has been approved for financing under the call Erasmus+ Capacity Building in Higher Education EAC/A05/2017, and will be coordinated by University of Novi Sad (UNS) during the period 15 November 2018 – 14 November 2021.

The wider aim of the SENVIBE project is to improve and build national educational capacities, cooperation and competences in dealing with environmental and occupational Noise and Vibration (No&Vib) engineering issues. One of the specific objectives of the SENVIBE project is to design new or to update the existing courses in the field of No&Vib for students of undergraduate programmes of different engineering departments: Environmental Engineering, Occupational Safety Engineering, Civil Engineering, Mechanical Engineering, Traffic Engineering and Electrical Engineering. Work package (WP) 'Development of modules and courses for different engineering departments' (WP3) is concerned with this specific objective. This Report is related to Task 3.2, dedicated to the new courses. It should be noted that the corresponding tailor-made outcomes have previously been defined. They are collected in the Report on Tailor-Made Learning Goals and Outcomes[1].

The subsequent sections list the new courses at four Serbian university from the SENVIBE consortium: University of Novi Sad (UNS), University of Nis (UNI), University of Kragujevac (UniKG) and Educons University from Sremska Kamenica (EUSK). The corresponding courses are listed in tables.

There are two remarks to be made regarding the changes with respect to the SENVIBE proposal and the original plans. The first change occurred with respect to one course targeted. It was written in the proposal that a new course will be introduced for the students of Traffic Engineering as ex ante analyses carried out at UNS did not identify it. However, while performing a detailed analysis in WP1 of the SENVIBE project, one optional course in the Traffic Engineering programme at UNS was identified, so it is not included into this Task 3.2 since this task covers new courses only. The second change occurred related to the appearance of this Report. Although the development of the courses was done timely and in accordance with the project schedule, the problems caused by COVID-19 and the restrictions introduced at certain institutions delayed the accreditation of some study programmes in which a few of them are included. The need to wait for the formal decisions and to have the courses officially accredited, caused this Report to appear more than a half of a year later than planned.

[1] https://senvibe.uns.ac.rs/wp-content/uploads/2019/04/SENVIBE_Report_Task1.2_version24April2019.pdf, pristupljeno 31.5.2020.

2. Design of new courses

REMARK 1: It is assumed that each course is taught during a semester that lasts 15 weeks.
REMARK 2: Table contains educational goals and outcomes, teaching methods, notes on course content and appropriate teaching/learning methodologies and comments

2.1 Environmental Engineering

2.1.1 Educons University of Sremska Kamenica

Table 2.1.1.1 Syllabus of the course

University	University Educons, Sremska Kamenica
Faculty	Faculty for Environmental Protection
Study programme	Environmental Safety https://educons.edu.rs/knjiga-predmeta/zastita-zivotne-sredine-kp/
Course title	Environmental Noise and Vibration https://educons.edu.rs/wp-content/uploads/2020/07/Knjiga-predmeta-OAS-ZZS.pdf
ECTS	8
Educational goals	• To equip students with the knowledge, understanding and application of noise and vibration principles and phenomena that underpin prudent use of the corresponding theoretical framework, computer software and experimental techniques. • To enable students to comprehend knowledge of: human and structural responses to vibration in environmental protection, human responses to environmental noise and the effects of noise and vibration on environment, as well as to integrate this knowledge into relevant practical applications and noise control in the field of Environmental protection.
Educational outcomes	By the end of the course, students should be able to: • identify and examine real noise and vibration issues; • recognize noise and vibration sources and phenomena and evaluate them through measurements; • suggest measures to solve noise and vibration problems;

	• understand the principal human and structural responses to vibration, as well as human responses to environmental noise; • recognize and select appropriate standards, recommendations, or regulations that apply to particular environments;
Course structure and content	30 classes of lectures + 15 classes of exercises in classroom + 15 classes of exercises in laboratory The concepts of sound and noise. The propagation of sound waves. Flat waves. Spherical waves. Sound intensity and sound pressure. Allowed sound pressure level and noise rating. Acoustic impedance. Sound power and characteristics of noise sources. Diffraction and reflection of sound. Noise spectrum. Indoor acoustic characteristics. Absorption characteristics. Reverberation time. Room size, shape and design as acoustic parameters. Noise isolation. Portability. Vibration isolation. Technical measures for protection against noise and vibration. Active methods of protection. Passive methods of protection. Identification of noise sources. Sound field calculation of industrial plants. Methods of design of noise protection systems. Criteria for evaluation of solutions of noise protection systems. Noise and vibration protection equipment.
Teaching methods	Lectures; Tutorial classes; Laboratory classes; Assignments.
Literature	1. M. Praščević , D. Cvetković, Environmental Noise, Faculty of Occupational Safety, University of Nis, Nis, 2005. 2. F.J. Fahy, D.J. Thompson, Fundamentals of Sound and Vibration, Taylor & Francis, 2015. 3. J.E.F. Foreman, Sound Analysis and Noise Control, Van Nostrand Reinhold, New York, 1990. 4. D.A. Bies et al., Engineering Noise Control, CRC Press, 2018.
Notes on course content and appropriate teaching/learning methodologies	E- or b-teaching/learning methodologies should be used to enable students not only to achieve the educational outcomes defined but also to acquire transferable and generic skills described in the comments below.
Comments	The following transferable and generic skills should be developed:

	• translate mathematical formulations into computer codes; • question the validity of modelling assumptions in the light of experimental data.

2.2 Civil Engineering

2.2.1 University of Kragujevac and University of Novi Sad (JOINT PROGRAMME AS ADDED VALUE)

Table 2.2.1.1 Syllabus of the course

University	University of Kragujevac, University of Novi Sad
Faculty	Faculty of Mechanical and Civil Engineering in Kraljevo Faculty of Technical Sciences in Novi Sad
Study programme	Civil Engineering http://www.mfkv.kg.ac.rs/index.php/izborni-predmeti-oas-gi
Course title	Noise Protection in Civil Engineering http://mfkv.kg.ac.rs/index.php/izborni-predmeti-oas-gi
ECTS	6
Educational goals	• To acquiring knowledge about principles of sound protection and elements of sound protection in buildings.
Educational outcomes	By the end of the course, students should be able to: • identify and examine real noise and vibration issues; • recognize noise and vibration sources and phenomena and evaluate them through measurements; • measure airborne and impact sound, • suggest measures to solve noise and vibration problems; • understand the principal human and structure responses to vibrations induced by traffic and other human-induced sources, as well as human responses to noise; • understand the principles of protection against structural sound and other elements relevant to sound protection • understand the existing engineering solutions in the areas of room acoustics and construction acoustics,

	• recognize and select appropriate standards, recommendations, or regulations that apply to particular environments; • define the acoustic quality of the building elements in accordance with the requirements of the standards and other legislation;
Course structure and content	45 classes of lectures + 15 classes of exercises in classroom + 15 classes of exercises in laboratory *Theoretical concepts* Physical concepts of noise and vibrations, noise measurement, indoor noise, elements of sound protection in buildings, principles for resolving sound protection in buildings, acoustic quality of building elements, design documentation and procedure of technical acceptance from the point of view of sound protection. *Practical work* Students in the laboratory or in the field perform measurements of sound pressure, sound intensity, reverberation time, insulating power of all types of bulkheads. Broadband noise measurement and analysis, time and frequency domain noise analysis. Laboratory and practical work is performed in the Laboratory for Acoustics and Technical Diagnostics and in field conditions.
Teaching methods	Lectures; Tutorial classes; Laboratory classes; Assignments.
Literature	1. H. Kurtovic, Fundamentals of Technical Acoustics, Naučna knjiga, Belgrade, 1982. 2. M. Mijić, Acoustics in Architecture, Nauka, 2001. 3. M. Praščević, D. Cvetković, Environmental Noise, Faculty of Occupational Safety, University of Niš, Niš, 2005. 4. M.J. Crocker, Handbook of Noise and Vibration Control, John Wiley & Sons, Inc., 2007. 5. J.E.F. Foreman, Sound Analysis and Noise Control, Van Nostrand Reinhold, New York, 1990. 6. D.A. Bies et al., Engineering Noise Control, CRC Press, 2018.
Notes on course content and appropriate	E- or b-teaching/learning methodologies should be used to enable students not only to achieve the educational

teaching/learning methodologies	outcomes defined but also to acquire transferable and generic skills described in the comments below.
Comments	The following transferable and generic skills should be developed: • translate mathematical formulations into computer codes; • question the validity of modelling assumptions in the light of experimental data;

2.3 Occupational Safety Engineering (ADDED VALUE)

2.3.1 University of Novi Sad

Table 2.3.1.1 Syllabus of the course

University	University of Novi Sad
Faculty	Faculty of Technical Sciences
Study programme	Occupational Safety Engineering http://www.ftn.uns.ac.rs/1203211706/inzenjerstvo-zastite-na-radu
Course title	Human Response to Noise and Vibration http://www.ftn.uns.ac.rs/916161627/efekti-buke-i-vibracija-na-coveka
ECTS	6
Educational goals	• To enable students to gather knowledge about the ways in which a person responds to noise and vibrations in the work environment • To understand the effects of noise and vibrations on the human body, and to integrate knowledge into practice.
Educational outcomes	By the end of the course, students should be able to: • understand the principal human responses to noise (i.e., perception, loudness, annoyance, speech interference, noise-induced hearing loss). • understand the principal human responses to whole-body vibration (i.e., perception, comfort, motion sickness, performance, and health) and hand-transmitted vibration (i.e., the hand-arm vibration syndrome, including vibration-induced white finger).

	• understand the principal methods of measuring and evaluating noise and vibration with respect to human responses. • recognise and select appropriate standards, recommendations, or regulations that apply to particular environments (e.g., domestic, commercial, transport, industrial).
Course structure and content	45 classes of lectures + 30 classes of experimental and numerical exercises The human auditory system. Noise and health. Hearing damage risk. Non-auditory health risks, vegetative responses. Disturbance of speech communication. Prediction. Standards. Annoyance at home and in other environments. Sleep disturbance. Planning and noise. Principles of the measurement and evaluation of human vibration exposures. Standards and Directives for whole-body vibration and hand-transmitted vibration. Health effects of whole-body vibration. Effects of whole-body vibration on activities. Discomfort produced by whole-body vibration. Vibration thresholds. Building vibration. Biodynamics (body transmissibility, apparent mass, models). Seating dynamics (transmissibility, SEAT value, models). Health effects of hand-transmitted vibration, their diagnosis, and prevention. Measurement, evaluation, and assessment of the vibration of powered hand-held tools. Causes of motion sickness in marine, land and air transport.
Teaching methods	Lectures; Tutorial classes; Laboratory classes (with computational exercises included); Assignments.
Literature	1. M.J. Griffin, Handbook of Human Vibration, Elsevier Science Publishing Co Inc, 1996. 2. K.D. Kryter The Handbook of Hearing and the Effects of Noise, Academic Press, 1994. 3. D. Cvetkovic, M. Prascevic, Noise and Vibration, Publishing Unit of the University of Nis, Nis, 2005.
Notes on course content and appropriate teaching/learning methodologies	E- or b-teaching/learning methodologies should be used to enable students not only to achieve the educational outcomes defined but also to acquire transferable and generic skills described in the comments below.

Comments	The following transferable and generic skills should be developed: • translate mathematical formulations into computer codes; • question the validity of modeling assumptions in the light of experimental data.

2.4 Mechanical Engineering

2.4.1 University of Novi Sad (ADDED VALUE)

Table 2.4.1.1 Syllabus of the course

University	University of Novi Sad
Faculty	Faculty of Technical Sciences
Study programme	Technical Mechanics and Technical Design http://www.ftn.uns.ac.rs/1032544600/tehnicka-mehanika-i-dizajn-u-tehnici
Course title	Noise and Vibration Protection http://www.ftn.uns.ac.rs/905541960/zastita-od-buke-i-vibracija
ECTS	4
Educational goals	• To acquiring knowledge of modern approaches in the field of noise and vibrations protection in the environment and occupational safety engineering systems. • Boosting scientific capacity, developing academic and practical skills in the field of noise and vibrations engineering as well as the application of active and passive methods for their control.
Educational outcomes	• Thorough understanding and knowledge of modern approaches of noise and vibration protection in the environment and occupational safety engineering systems. • Boosted scientific capacity, developed academic and practical skills in the field of noise and vibrations engineering as well as the application of active and passive methods for their control.

Course structure and content	45 classes of lectures + 30 classes of experimental and numerical exercises Physical and physiological acoustics. Frequency analysis. Measuring the sound intensity. A selection of measuring spots. Instruments for measuring noise, preparing for measurement and measurement. Room acoustics. Reverberation aand anechoic chamber. Acoustic treatment of the premises. Barriers. Vibration analysis: parameters, converters, linear and logarithmic scales. Vibrational testing: impulse versus shaker. Experiments with transient signals. Experiments with stationary signals. Post-processing experimental signals in MATLAB. Getting an amplitute-frequency curve. Passive control in theory and experiments: the influence of damping at different excitation frequencies. Vibration control by adding mass in theory in experiments. Isolators and absorbers. Equipment for noise protection and vibrations.
Teaching methods	Lectures; Tutorial classes; Laboratory classes (with computational exercises included); Assignments.
Literature	1. D. Cvetkovic, M. Prascevic, Noise and Vibration, Publishing Unit of the University of Nis, Nis, 2005. 2. I. Kovacic, D. Radomirovic, Mechanical Vibrations, John Wiley&Sons, 2017. 3. C.R. Hibbeler, Engineering Mechanics, Pearscon Education, 2016.
Notes on course content and appropriate teaching/learning methodologies	E- or b-teaching/learning methodologies should be used to enable students not only to achieve the educational outcomes defined but also to acquire transferable and generic skills described in the comments below.
Comments	The following transferable and generic skills should be developed: • translate mathematical formulations into computer codes; question the validity of modelling assumptions in the light of experimental data.

4. Summary and conclusions

This Report contains the list and the descriptions of four new courses on Noise&Vibration that have been introduced at three Serbian universities during the SENVIBE project as a result of the project activities. The report is complementary to the SENVIBE Report on Redesign of Existing Courses. What is important to note is that all the new courses are either accredited by the National Accreditation Body or officially recognised at the institutions concerned. To validate this fact, the previous tables provide the links to the institutional websites where these study programmes and the courses are announced. The accreditation/institutional recognition of these courses is the important result that highlights their quality and makes them sustainable for future implementations.

Considering this Report on the Design of New Courses together with the SENVIBE, it is apparent that there are more new undergraduate courses developed and accredited than planned, which represents an impressive result given the circumstances caused by COVID-19. Some of the courses are introduced jointly between the universities from the consortium, which had not been planned, but this achievement also represents the added value as it contributes to the project sustainability. The added value also regards two new courses on Noise&Vibration at UNS, which had not been planned: one at the undergraduate academic programme of Occupational Safety Engineering, and the other one at the master academic study programme for Mechanical Engineering - Technical Mechanics and Technical Design. The former has been introduced in full correspondence with the same course[2] taught at the SENVIBE partnering university – University of Southampton, Institute of Sound and Vibration Research, Southampton, United Kingdom, which also reflects the benefits gained during the project that will sustain after its completion.

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[2]ISVR3061 Human Responses to Sound and Vibration, https://www.southampton.ac.uk/courses/modules/isvr3061.page, pristupljeno 22.11.2020.

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