Co-funded by the Erasmus+ Programme of the European Union

Erasmus + Project No 598241-EPP-1-2018-1-RS-EPPKA2-CBHE-JP

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

S E N V I B E

Survey and comparison of Serbian and EU education in Noise and Vibration

Deliverable 1.1

Date: 22/01/2019

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 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 in accordance with ongoing EU integration strategies and the needs identified in Serbia.

The very first task of the SENVIBE project (Task 1.1[1]) covers the survey of education in Serbia and EU in the No&Vib fields at different types (levels) of higher education, with the focus on the following engineering disciplines: Mechanical Engineering, Electrical Engineering, Environmental Engineering, Occupational Safety and Health Engineering, Civil Engineering and Traffic Engineering. Given the survey results for Serbia, the main focus and the majority of the results regard undergraduate academic studies[2], while some details about the other ones are given as well. The Report covers accredited private and public universities in Serbia separately, which has not been done so far on the national level in this respect and in these fields. Besides the existence of courses/programmes, their content is also of interest. This Report provides a foundation for future activities in the SENVIBE projects, identifying possibilities for improvements regarding modernization of the existing courses in the No&Vib fields as well as the development and implementation of new courses for students of different programmes at different education circles, which will be dealt with in later stages of the SENVIBE project.

---

[1]The tasks can be seen at the SENVIBE web-site, https://senvibe.uns.ac.rs/about/#Outcomes.

[2]Note that SENVIBE Task 1.4. Review and analysis of the existing MSc VAE programmes in EU regards Master programmes in this field in EU, while such Master programmes do not exist in Serbia. Therefore, thesse programmes are not included in this report, but in the Report for Task 1.4. In addition, MSc courses related to No&Vib tought in Serbia will be included therein as well for comparison reasons.

Co-funded by the Erasmus+ Programme of the European Union

Given the fact that this Report regards certain national educational capacities, the info about it will be distributed to all project partners as well as to certain national, regional and local authorities, including the Ministry of Education, Science and Technological Development, the Ministry of Environmental Protection and the Conference of the Universities of Serbia, which encompasses all accredited universities in Serbia.

2. Noise and Vibration education in Serbia

This section first provides general information about the higher education system in Serbia (Section 2.1) and then covers information about the education in the No&Vib fields in Serbia both at public universities (Section 2.2) and private universities (Section 2.3).

2.1 General facts about Higher Education in Serbia

The following link gives general information about the higher education system in Serbia (Accessed on 31 December 2018):

http://studyinserbia.rs/en/education/higher-education

There are two types of studies in the Serbian system of higher education:
• **academic studies**, organized mainly at universities, and
• **applied studies**, organised either at colleges of applied studies or at universities.

Serbia **joined the Bologna Process in 2003** and thus initiated a gradual reform process, which received its legal support in 2005 via a new Law on Higher Education. This law formally **introduced the European Credit Transfer System, three-cycle system of study and diploma supplement.** From 2007/08, all new students study under the new reformed study programmes at all higher education institutions.

The three-cycle system of academic studies includes:
• **Bachelor (undergraduate) studies**, which usually last four years with 240 ECTS[3], although three-year/180 ECTS Bachelor programmes are also available;
• **Master studies** lasting one-two years with 60 to 120 ECTS;
• **Doctoral studies (PhD)** with a minimum of three years of study or 180 ECTS.

There are also **integrated studies**, for example in the field of medical science, dentistry and veterinary medicine, which last six years and must carry a minimum of 360 ECTS.

---

[3]European Credit Transfer System. This is a central tool in the Bologna Process, which aims to make national systems more compatible. ECTS credits represent the workload and defined learning outcomes ("what the individual knows understands and is able to do") of a given course or programme. 60 ECTS are the equivalent of a full year of study or work.

In addition, the second cycle of academic studies includes **specialist academic studies** with the minimum duration of one year with 60 ECTS if a student has achieved a total of 300 ECTS in previous studies.

The two-cycle applied (vocational) studies consists of:
• **Bachelor applied studies**, which last three years and have 180 ECTS;
• **Specialist applied studies**, which carry 60 ECTS and last one year;
• **Master applied studies**, which last two years and carry 120 ECTS.

All higher education institutions must be accredited in order to obtain a license issued by the Ministry of Education, Science and Technological Development of the Republic of Serbia. Private higher education institutions (not founded by the state) have the same status as public ones.

An overview of undergraduate engineering curricula related to Noise, Vibration and Technical Acoustics are provided in separate sections for accredited public (Section 2.2) and private universities (Section 2.3) in Serbia. Note that this overview only regards engineering disciplines of interest for the SENVIBE project as emphasized in the Introduction section (Mechanical Engineering, Electrical Engineering, Environmental Engineering, Occupational Safety and Health Engineering, Civil Engineering and Traffic Engineering).

It is important to note that neither Bachelor programme for Vibro-Acoustics or Sound and Vibration, nor such Master programme exists in Serbia. This is a very important issue to be addressed by the SENVIBE project. There are no dedicated PhD programmes (doctoral academic studies) for it either. There are, however, some courses that students can have during doctoral academic studies, and some of them are listed in the next section. These are seen as only isolated examples and there is no evident, widely spread and continuous track in formal academic education in No&Vib through the three-cycle system in Serbia.

2.2 Public universities in Serbia

Task 1.1. of the SENVIBE project includes the analysis of study plans and programmes of basic academic studies at all accredited state universities in Serbia in certain engineering programmes (see the Introduction section for their list). Only accredited universities in Serbia are the members of the Conference of the Universities of Serbia (KONUS). Among them are the following state universities, which were included into this analysis:

1. University of Belgrade (UBG);
2. University of Novi Sad (UNS);
3. University of Niš (UNI);
4. University of Kragujevac (UniKG);
5. University of Prishtina with provisional headquarters in Kosovska Mitrovica (UPKM);
6. State University in Novi Pazar (UNP).

In addition to the institutes, centres and library, University of Belgrade comprises 31 faculties, five out of which were included in this analysis, as they belong to the field of technical and technological sciences: Faculty of Architecture, Faculty of Civil Engineering, School of Electrical Engineering (UBG-ETF), Faculty of Mechanical Engineering and Faculty of Transport and Traffic Engineering.

University of Novi Sad comprises 14 faculties, and this analysis covered the following faculties: the Faculty of Technical Sciences (UNS-FTN), Faculty of Civil Engineering in Subotica (UNS-GF) and Technical Faculty "Mihajlo Pupin" (UNS-TFMP).

There are 14 faculties within University of Niš, whose four faculties were covered by this survey: Faculty of Civil Engineering and Architecture (UNI-GAF), Faculty of Electronic Engineering (UNI-EF), Faculty of Mechanical Engineering (UNI-MF) and Faculty of Occupational Safety (UNI-FZNR).

The University of Kragujevac is composed of 12 faculties, and the following three faculties were covered by this survey: Faculty of Engineering (UniKG-FIN), Faculty of Mechanical and Civil Engineering (UniKG-FMG) and Faculty of Technical Sciences,

Faculty of Technical Sciences (UPKM-FTN) of the University of Prishtina is the only one that fits into the subject of this analysis from the remaining nine faculties of this university.

The State University of Novi Pazar is currently the only integrated university in Serbia and encompasses 10 departments, but only the Department of Technical Sciences (UNP-DTN) fits into the scope of this survey. The remaining faculties and departments at these six universities are omitted because the areas they deal with are not directly linked to No&Vib.

A detailed overview of the courses whose contents include No&Vib or their aspects, which are taught at accredited state universities in Serbia, is given in the table in **Appendix I**. In addition to the title of the courses, the table also lists the detailed content of the course, outcomes, methods of teaching, the name of the university and the faculty or the study programme, as well as the source used for this survey. It should be emphasized that the search and analysis given herein is based on official data on these programmes, courses and course plans available at official websites of the universities and faculties. This implies that the situation is subject to changes depending on the accreditation dynamics for each individual study programme. For this reason, the last column of the table given in **Appendix I** specifies the date when details about these course were recorded.

At the completion date of this report, **at the accredited state universities in Serbia, at targeted study programmes in the field of technical and technological Sciences, 31 courses were detected in basic academic studies, which directly, or at least to a non-negligible extent, deal with or contain aspects related to No&Vib and Technical Acoustics.** The courses vary notably according to the degree of study of the subject matter. Courses that clearly or dominantly deal with No&Vib, Theory of Oscillations or Technical Acoustics are:

- Oscillation Theory (UNS-FTN, study programme Mechanical Engineering/Mechanical Engineering and Construction Engineering/Technical Mechanics and Design in Engineering/Manufacturing Engineering);
- Noise, Vibration and Design (UNS-FTN, study programme Mechanical Engineering);
- Acoustics and Noise Protection (UNS-FTN, Environmental Engineering);
- No&Vib [Protection (UNS-TF, Environmental Engineering);
- No&Vib (UNI-FZNR, Occupational Safety);
- Noise in the Environment (UNI-FZNR, Environmental Protection);
- Dynamics of Earthquake Engineering (UNI-GAF, Construction);
- Acoustics (UNI-EF, Telecommunications);
- Mechanics 4 (Oscillation Theory) (UNI-MF, Department of Mechanical Engineering);
- Machine Dynamics, MVM testing (UniKG-FIN, direction Mechanical Engineering);
- Sustainable Development of Motor Vehicles (UniKG-FIN, Department of Automotive Engineering);

- Maintenance and Diagnostics, Oscillations of Mechanical Systems, Machine Dynamics, Measuring Technique, Noise Protection (UniKG-FMG, study programme Mechanical Engineering);
- Basics of Environmental Engineering, Building (UPKM-FTN, Department of Civil Engineering);
- Electroacoustics (UPKM-FTN, Department of Electrical and Computer Engineering);
- Mining Protection Systems, No&Vib, Occupational No&Vib Protection (UPKM-FTN, study programme Environmental protection and safety at work);
- Vehicle Dynamics, Oscillation Theory (UPKM-FTN, study programme Mechanical Engineering);
- Technical Protection, Basics of Environmental Engineering (UPKM-FTN, Department of Mining Engineering);
- Electroacoustics (UNP-DTN, study programme Audio and video technology).

At the majority of universities, there are courses that, to a smaller extent, deal with noise, vibration or technical acoustics, such as:

- Electrical Acoustics (UBG-ETF, Department of Electrical Engineering and Computing, Modules Electronics/Telecommunications and Information Technologies);
- Introduction and Principles of Environmental Protection (UNS-FTN, Environmental Engineering);
- Stability and Dynamics of Construction (UNI-GAF, Civil Engineering);
- Sensors and Actuators (UniKG-FIN, Department of Mechanical Engineering).

It is important to point out here that the vast majority of the previously mentioned courses are elective. It should also be emphasized that there are a strikingly large number of directions and modules, where there are no courses dealing with the subject of No&Vib, although it is clear that by the nature of the study programme those courses should exist. For example, on accredited study programmes in the field of Traffic and Transport Engineering at the Serbian state university, there is no course in the basic studies on the subject. The absence of a subject is also apparent in the study programmes that have a large number of modules without a single subject from No&Vib. Such are the modules of the University of Belgrade (Faculty of Civil Engineering, modules: Hydraulic and Environmental Engineering, Road, Railway and Airport Engineering, Management,

Technology and Informatics in Civil Engineering, Structural Engineering) and modules of the University of Novi Sad (Faculty of Civil Engineering in Subotica, modules: Structures, Hydraulic and Water Engineering, Roads, Architectural Engineering, Geodesy).

As already noted, there are no dedicated PhD programmes (doctoral academic studies) for No&Vib in Serbia. There are, however, some courses that students can have during doctoral academic studies and are related to it entirely or partially (note that some of them do it to a very small extent). Some examples are:

- Advanced Topics of Missile Guidance, Selected Chapters of Mechanics; Advance Techniques in IC Engines – Selected Topics; Digital Processing of Non-stationary Signals; Dynamic Problems of Rail Vehicles; Inverse Analysis in Material Characterization; Product Development in Mechanical Engineering, Reliability and Dynamics of Power Transmission Units (Faculty of Mechanical Engineering, UBG);
- Room Acoustics, Acoustical Measurement Techniques, Modeling of Sound field, Selected Topics in Room Acoustics, Acoustic Design of Rooms units (School of Electrical Engineering, UBG);
- Selected Chapters in Acoustics and Audio Engineering (Electrical and Computer Engineering, UNS-FTN);
- Nonlinear Vibration (Technical Mechanics, UNS-FTN);
- Advanced Methods for No&Vib Control, Advanced Methods for No&Vib Measurements and Monitoring (Faculty of Occupational Safety, UNI);
- No&Vib of Mechanical Systems (Faculty of Mechanical and Civil Engineering in Kraljevo, UniKG);
- Vehicle Dynamics, Mechanical Vibrations, Machine Design (Mechanical Engineering, UPKM).

2.3 Private universities in Serbia

The following private accredited universities, which are the members of the Conference of the University of Serbia (KONUS) have been covered by this survey:

1. Megatrend University, Belgrade;
2. Singidunum University, Belgrade;
3. Alfa University, Belgrade;

4. European University, Belgrade;
5. Educons University, Sremska Kamenica;
6. Belgrade Metropolitan University, Belgrade;
7. University Business Academy, Novi Sad;
8. Union University, Belgrade;
9. University 'Union-Nikola Tesla', Belgrade.

After a detailed analysis of different plans and programmes at the mentioned universities, only one subject dealing with No&Vib was identified. It is run at the Faculty of Construction Management, University 'Union-Nikola Tesla', Belgrade. At other universities, no courses on such subject were identified.

A detailed overview of the subject whose content includes No&Vib is given in the table in **Appendix II**. The search and analysis were based, as in Section 2.2, on the same form of the table from Appendix I. The last column of the table in Appendix II indicates the date on which a particular course is surveyed.

At the completion date of this report, in the field of technical and technological sciences, only one mandatory subject was detected in academic studies at private universities in Serbia, which is directly related to the field of No&Vib:

• Contemporary design methods, University 'Union-Nikola Tesla' Belgrade, Faculty of Civil Engineering, Department of General Construction.

3. Noise and Vibration education in the EU

This section provides first general information about the higher education system in EU (Section 3.1) and then about European education in Acoustics and Vibration Engineering (Section 3.2). Its last part (Section 3.3) describes in details three representative undergraduate programmes in Sound and Vibration in EU.

3.1 General facts about Higher Education in EU

Education is seen as essential to develop a more inclusive, cohesive and competitive Europe. The renewed EU agenda for higher education, adopted by the European Commission in May 2017, identifies four key goals for European cooperation in higher education:

1. Tackling future skills mismatches and promoting excellence in skills development;
2. Building inclusive and connected higher education systems;
3. Ensuring higher education institutions contribute to innovation;
4. Supporting effective and efficient higher education systems.

To help achieve each of these goals, the European Commission proposes specific actions at EU-level, primarily supported by different strands of the Erasmus+ and Horizon 2020 programmes. In particular, the European Commission supports:

- the exchange of good policy practices between different countries through the ET2020 higher education working group;
- the Bologna Process, designed to promote the internationalisation of higher education in Europe through more mobility, easier recognition of qualifications and streamlined quality assurance mechanisms;
- the development and use of mobility and recognition tools, such as the ECTS system and the Diploma Supplement.

The European Commission has recently taken a number of further initiatives:

- the concept of Networks of European Universities brings a major change to higher education practices, through integrated curricula and mobility, thus fostering quality, excellence and innovation;
- the proposed Council recommendation on automatic mutual recognition of higher education and school-leaving diplomas helps to remove barriers to student mobility within Europe;

- the future European Student Card will facilitate the secure exchange of student information and reduce administrative burden for higher education institutions..

The Study in Europe web-site, which covers higher education in 33 European countries, supported by the European Commission, gives general information about the higher education system in EU (Accessed on 17 January 2019):

https://ec.europa.eu/education/study-in-europe/planning-studies/european-higher-education_en

Each country has its own individual higher education system – but all are part of the European Higher Education Area (EHEA), whose system helps ensure that higher education systems across Europe are compatible. Qualifications across Europe are comparable through the European Qualifications Framework (EQF). The European Qualifications Framework is a translation tool that helps communication and comparison between qualifications systems in Europe. Its eight common European reference levels are described in terms of learning outcomes: knowledge, skills and competences. This allows any national qualifications systems, national qualifications frameworks (NQFs) and qualifications in Europe to relate to the EQF levels. These levels can be used to understand and compare qualifications awarded in different countries and by different education and training systems.

The main higher education qualifications offered across Europe include the following degrees:

- **Bachelor's:** most of them last three or four years;
- **Master's:** most of them last one or two years;
- **Doctorate/PhD:** most of them last around three or four years.

Besides these three main study levels, there are also other higher education qualifications – such as professional diplomas and more. Essential info on study programmes, scholarships and student life across Europe are given at

https://ec.europa.eu/education/study-in-europe/country-profiles

The majority of the countries in the EHEA[4] have adopted ECTS. The ECTS Users' Guide (online version) describes the ECTS credit system, and how to use it. A typical 'first cycle' (Bachelor's) Degree, would consist of 180 or 240 ECTS, whereas a typical 'second

[4]This is not the case for the UK, for example. Many universities in the UK use the Credit Accumulation and Transfer Scheme (CATS), which is described in Section 3.3.

cycle' (Master's) Degree, would consist of 90 or 120 ECTS, with at least 60 credits at second cycle level. The use of ECTS at the 'third cycle' (or PhD level) varies.

3. 2. European education in Acoustics and Vibration Engineering

The data collected and hosted in the database of the EEA (European Acoustics Association) Schola map provide a general overview of the education in the No&Vib Engineering:

https://euracoustics.org/activities/schola/

The EEA Schola map is actually an online study guide of Acoustics in Europe. Representatives from universities, faculties, departments, schools, institutes, called 'Schola Editors', insert the data of their courses, specific fields of acoustics research, and exchange programs. The map downloaded from the EEA Schola map (Accessed on 17 January 2019) shows the existence of a relatively dense representation in Europe, especially in the northern and central continental Europe.

Figure 1. EAA Schola map (downloaded on 17 January 2019)

A general overview of the education in the No&Vib Engineering for two countries that have the highest international reputation in this respect – the United Kingdom and Sweden is provided below[5].

Higher education in the UK takes several forms. The first form encompasses undergraduate degrees:

- MEng - Master of Engineering;
- BEng - Bachelor of Engineering;
- BSc - Bachelor of Science.

There are also postgraduate degrees, where the latter are separated into taught MSc programmes (typically two thirds taught content and one third research project), MRes programmes (typically a third taught content and two thirds research project), or full higher research degrees such as:

- MPhil - Master of Philosophy, which is a pure research degree, based entirely on the completion of an independent thesis. As such, it sits somewhere between other Masters qualifications and more advanced postgraduate research training:
- PhD;
- EngD - Engineering Doctorate, which is a degree of the same academic standing as a PhD, but with a very strong industrial focus.

Possibly unique to the EU and elsewhere, there are some undergraduate degrees in the UK that major in Noise and Vibration or similar in comparison to degrees that are more general, such as those in Mechanical or Electronic Engineering that have some small elements of Acoustics and Vibration. Another point of note is that only some of these specific undergraduate degrees are engineering degrees, only a smaller subset of which are recognised and accredited by professional engineering bodies, such as the IMechE (the Institute of Mechanical Engineers see http://www.imeche.org/). These accredited degrees meet the UK-Spec requirements for the academic content to be suitable to use for subsequent engineering registration as a chartered (CEng) engineer.

[5]These descriptions are written by the representatives of the EU partners in the SENVIBE project: Neil Ferguson from the University of Southampton, Institute of Sound and Vibration Research, Southampton, United Kingdom, and Hans Boden from the Kungliga Tekniska Högskolan, Stockholm, Sweden.

The following list shows the current degree title and location of taught undergraduate degrees in specifically Noise (Acoustics, Audio or Music Technology) and Vibration:

- Physics with Acoustics, BSc, University of Salford;
- Acoustical and Audio Engineering, BEng and MEng, University of Salford;
- Audio and Acoustic Engineering, BEng and MEng, Solent University (Southampton);
- Audio Engineering, BSc, Solent University (Southampton);
- Acoustical Engineering, BEng and MEng, University of Southampton.

Note that the previous list does not include degrees that are focused on music or are primarily vocational and cater for professional audio, sound recording, production or performance. In addition, there is a taught one-year part time diploma in acoustics and noise control for graduate entry run since 1975 by the Institute of Acoustics, the professional engineering body in the UK. This is primarily vocational focused covering fundamental science and engineering but also applicable modules in environmental noise, practical noise control and noise regulations for employed practitioners in environmental noise enforcement, noise consultants and can lead to partial academic exemption for the award of an MSc from a number of UK universities including Derby and Solent universities.

Many universities in the United Kingdom use, unlike the EU, the Credit Accumulation and Transfer Scheme (CATS), where nominally 10 CATS are equivalent to 5 ECTS. A full academic year is worth 120 credits and a full calendar year (normally only at postgraduate level) 180 credits. Typically, in England, Wales and Northern Ireland, a Bachelor's degree with honours requires 360 credits; an ordinary Bachelor's degree requires 300 credits; a foundation degree requires 240 credits; an integrated Master's degree requires 480 credits; a postgraduate taught Master's degree requires 180 credits (typically 120 taught CATS followed on in parallel with a research project worth 60 CATS points); and a professional Doctorate requires 540 credits with 360 at level 8.

Swedish universities offer degree programmes according to the European standard. This includes Bachelor’s (usually three years long and180 ECTS), Master’s (one or two years long with 60 or 120 ECTS) and PhD programmes.

When it comes to the education in Acoustics and Vibration Engineering in Sweden, it is important to note that there are no BSc programmes in Noise and Vibration, but there are courses given in different programmes. The traditional Swedish engineering degree is a five-year programme leading to a MSc in Engineering. These days, the five-year programmes are split into three years for a BSc and two additional years in an MSc programme. Each academic year, both for BSc and MSc, has 60 ECTS. The students at major engineering universities such as KTH – Royal Institute of Technology and Chalmers University of Technology are admitted directly to a five year MSc programme where they need to choose a Master programme for the last two years. They can get a BSc after the first three years, which would make it possible to apply to a Master programme at another university in Sweden or in another country. It is however very rare that students do this. There are also some three year BSc in Engineering programmes which are less theoretical and more focussed on engineering skills. A student in these programmes is, different from the students admitted to the five year (Master of Science in Engineering) programmes, not guaranteed a place at a Master programme but must apply in competition with other external students. The education during the first three years (the BSc part) is completely in Swedish, even though there may be course books in English. This is different from the education in Master programmes, which is completely in English, including Chalmers and KTH Master programmes in Technical Acoustics[6]. There is the BSc programmes in Luleå (Luleå University of Technology) and Örebro (Örebro University), but they are audio oriented.

3.3. Representative undergraduate programmes in Sound and Vibration in Europe

This section provides details of the undergraduate programmes at three universities which offer representative undergraduate programmes for the fields covered by this Report. They are:

- University of Southampton, Southampton, UK;
- Technical University of Denmark, Lyngby, Denmark;
- University of Le Mans, Le Mans, France.

An overview of each of them is given respectively in Sections 3.3.1, 3.3.2 and 3.3.3, while detailed descriptions of their course are given in the table in **Appendix III**.

[6]More details about these Master programmes will be given in the Report for Task 1.4 of the SENVIBE project.

3.3.1 University of Southampton (Southampton, UK)

The University of Southampton offers:

- BEng/MEng (Hons) Acoustical Engineering (3/4 years).

Southampton's BEng Acoustical Engineering degrees combine a thorough grounding in the skills all engineers need with concentrated specialization in Acoustics, Vibration and their human effects. The first year provides a background in Acoustics, emphasizing the Physics and Mathematics of Acoustics, Sound and Vibration. The second year covers further Acoustics, Vibration, Mathematics, Design, Fluid Dynamics and introduces Audio Technology and Control. There is a total of 120 credits across two semesters. A large element is the design project. The third year differs from the previous two years as a student is offered a choice of modules to study alongside the compulsory ones. This allows a degree of specialization. In addition, students are strongly advised to undertake at least 20 weeks of engineering related work placements. This is typically achieved by 10-week placements after their second and third years or a single placement in a gap year after Year 2 or 3. All students also undertake a substantial individual project in Year 3. This can either be on a topic selected from a list proposed by teaching staff or it could be an idea of their own, with appropriate permission and guidance. It is expected that students will spend one third of their time in Year 3 on their individual project. At the end of Year 3 there is an exit award of BEng (Hons) Acoustical Engineering. Year 4 (MEng Acoustical Engineering only) features an extensive group design project to solve an industrially focused problem in an area of acoustics. Students are also required to take a selection of optional modules,

This BEng fully meets the academic requirement for registration as an Incorporated Engineer and partly meets the academic requirement for registration as a Chartered Engineer in the UK. MEng fully meets the academic requirement for registration as a Chartered Engineer. The planned intake involves 25-30 students, but the average number of applications per place is three candidates, which implies that there is a considerable interest for studying this programme.

According to the the UK National Student Survey from 2018, 92% of Acoustical Engineering students were satisfied or very satisfied with the overall quality of their course.

Students can also take the Industrial Placement Year, which is an additional year-long module that allows them to apply for a placement with an engineering-based organisation. The successful placement is recognized on their Degree Certificate.

Graduates from this engineering degree course are highly employable. They are provided with a dedicated Employment Officer who help build their skills profile and point you in the right direction. The university also has connections with local, national and international employers.Their recent graduates work for a range of companies, from SMEs to large ones.

The courses are taught at the Institute of Sound and Vibration Research (ISVR). ISVR was formed in 1963, and was awarded the prestigious Queen's Anniversary Prize for its achievements in higher education and is one of the leading brand names in Acoustics, known and respected worldwide. ISVR facilities include two reverberation chambers, a large anechoic chamber, a product development lab for noise and vibration, a combustion noise rig and a range of electrodynamic shakers. The laboratories are well served with comprehensive control and preparation areas. A wide range of modern, highly specialised instrumentation is available. Single and three phase electrical supplies at 50, 60 and 400 Hz, compressed air and cooling water can be provided. Mechanical workshop and handling facilities are readily accessible. Access is also available to testing and research facilities, such as wind tunnels and water tanks for underwater acoustics, which are operated by other groups or departments at the University of Southampton. The facilities are complemented by a comprehensive suite of noise and vibration measurement and analysis equipment, dedicated automotive NVH manipulation software, optical and laser torsional measurement equipment, multi-channel high-speed data acquisition, digital sound quality and editing software. Analytical facilities include Finite Element, Statistical Energy, Modal Analysis packages and Matlab.

3.3.2 DTU Technical University of Denmark (Lyngby, Denmark)

The Technical University of Denmark (DTU) offers:

- BEng in Electrical Engineering with a specialization in Sound and Acoustic Technology.

This undergraduate programme lasts three and a half years, with the courses taught in Danish language. The education is structured as a compulsory basic education that extends over the first four semesters and includes compulsory courses that provide a foundation in Mathematics, Physics, Electronics, Programming and Signal Processing, but students also learn to develop analog and digital electronic systems. The second year is oriented towards professional and applied courses thus paving the path for a choice of a specialization topic. This occurs during the fifth semester in form of an innovation course (common to all undergraduate engineering programmes), where emphasis is on interdisciplinary approach to executing innovative projects with industrial partners, as well as an additional pool of elective specialization courses. The specialization consists of 40 ECTS elective courses that can be selected from a list of over 60 different courses, a diploma engineering internship in a company of 30 ECTS (20 weeks) and a diploma engineering project of 20 ECTS (13 weeks) made in, or in collaboration with a company.

An excellent education in Sound and Vibration at this BSc, and also on the associated MSc and PhD levels are offered by Acoustic Technology, which is one of the research groups at the Department of Electrical Engineering at DTU. Their facilities include: two anechoic rooms (a large and a small one); three reverberation rooms each of about 240 m^3 (two adjoining rooms for measurement of transmission loss of walls, and one below one of the others for measurement of transmission loss of horizontal partitions); one reverberation room of about 240 m^3 for sound power and absorption measurements; a scale model of a concert hall; a listening room according to IEC 268-13, which can be used, for example, for loudspeaker comparisons.

3.3.3 University of Le Mans (Le Mans, France)

The University of Le Mans offers the following programme of interest for this report:

- 'BAC + 3 degree' Professional Licence Engineering (*Licence professionnelle Ingénierie*), Acoustics and Vibration;
- 'BAC + 3 degree' Engineer in Technical Sciences, specialization in Acoustics (*Licence Sciences pour l'Ingénieur (SPI*[7]*), parcours Acoustique)*.

Note that 'Licence' corresponds to a Bachelor degree, while the notation with '+3' indicates that one will complete three years of university studies after passing the French *Baccalauréat*[8] exam. Attaining 180 ECTS will earn a Licence.

The main objectives of the Professional Licence Engineering (*Licence professionnelle Ingénierie*), Acoustics and Vibration are: i) to train specialists in the field

[7]The SPI License changes its name at the beginning of 2019, for the first year of the license, and becomes Acoustic License and Vibrations). In 2021, the mention Acoustics and Vibrations will replace completely the mention SPI (https://sites.google.com/site/licenceacoustiquelemans/home,Accesses 19 January 2019).
[8]A diploma awarded by the French Ministry of National Education. It marks the successful completion of secondary studies and opens the doors to higher education.

of acoustics and vibrations, able to intervene in the sectors of transport, services, environment, materials, etc; ii) to promote the acquisition of professional skills in acoustic and vibration measurements and modeling; iii) to promote integration into the workplace through training including theoretical and practical courses taught by specialists in acoustics and vibrations (teacher-researchers and industry), and a 13-week internship in a company. This Professional License aims to train technicians specialized in acoustic and vibratory measurements and their diagnoses. According to the previous experience, after completing this degree, such specialists have found jobs in: offices study or control offices (45%), business related to transportation (21%) or large groups specialized in acoustics and industrial vibrations (23%). The first year contains courses that help students strengthen the basics in mathematics and physics. The second year introduces specialized courses. Objectives of the third year of specialization are: upgrade in acoustics and vibrations, acquisition of basic professional knowledge; 140 hours of a project; 165 hours of lessons learned by professional speakers and minimum 13 weeks internship.

The second option - Engineer in Technical Sciences, specialization in Acoustics will learn to: i) use the mathematical tools to model simple acoustic and vibration phenomena; ii) perform measurements and process their results; iii) validate a model by comparing its predictions to the experimental results and assess its validity limits; iv) utilize concepts in Mathematics and Physics to address specific problems in different industrial fields; v) implement algorithmic and programming techniques to develop simple data acquisition and processing applications, etc; vi) understand the professional world of acoustics (trades, functions and structures). The first year is a general year of scientific, socio-economic, cultural and linguistic education, and offers modules of discovery of acoustics. The Years of 2 and 3 make it possible to specialize progressively in acoustics. This is a unique programme in France. More than 2000 students have been trained for 25 years and a hiring rate of over 90% in the field of Acoustics as technicians, engineers, researchers and entrepreneurs.

Teaching staff is from the Laboratory of Acoustics (LAUM) at the University of Le Mans. In LAUM there are different specific rooms are dedicated to experimentation[9]: an anechoic room, a semi-anechoic room, an air-conditioned room for the characterization of absorbent materials, a soundproof room dedicated to urban acoustics activities, two optical holography rooms, two opto-acoustic rooms, a

[9]This list is provided by Professor Yves Aurégan, Directeur de recherche au CNRS, Laboratoire d'Acoustique de l'Université du Maine.

microtechnology platform, a room dedicated to the Evaluation and Non-destructive Testing (ECND) of materials, a room dedicated to the granular materials activity, a mechanical test room, a room dedicated to vibro-acoustic activities, a room housing research activities in guided acoustics with flow. In addition, a generic instrumentation pool is shared for all laboratory activities (impedance tubes, analyzers, vibrometers, synchronous detectors, fast camera, accelerometers, pressure sensors and microphones, amplifiers, pre-amplifiers and signal conditioners, signal generators, oscilloscopes, multi-channel acquisition systems and vibrating pots with associated amps).

4. Summary and conclusions

This Report is a deliverable associated with the very first task (Task 1.1) of the SENVIBE project '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/

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 in accordance with ongoing EU integration strategies and the needs identified in Serbia. Its Task 1.1 covers the survey of education in Serbia and EU in the No&Vib fields at different types (levels) of higher education, with the focus on the following engineering disciplines: Mechanical Engineering, Electrical Engineering, Environmental Engineering, Occupational Safety and Health Engineering, Civil Engineering and Traffic Engineering. The main focus and the majority of the results regard undergraduate academic studies, while some details about the other ones are given as well.

The Report covers accredited private and public universities in Serbia separately, which has not been done so far on the national level in this respect and these fields.

There is no continuous track in formal academic education in No&Vib/Acoustic and Vibration/Sound and Vibration through the three-cycle system in Serbia. Neither Bachelor programme for Vibro-Acoustics/Sound and Vibration, nor such Master programme exists in Serbia. This is a very important issue to address by the SENVIBE project in future.

The survey conducted for Serbian public universities has shown three types of courses for undergraduate students of the investigated engineering departments: i) not related to No&Vib Engineering or Technical Acoustics, and they are out of the scope of this Report; ii) related to No&Vib Engineering; iii) having weak links with No&Vib Engineering or Technical Acoustics. This third group of courses is not covered by this Report. However, it has been noted that these courses, among which are, for example, courses of Physics or Engineering Mechanics, are usually taught at the beginning of academic studies. As such, they cover larger number of students with respect to the course under ii) and provide a good basis for widening the pool of the students that can be thought about this subject, contributing to the improvement of national educational capacities in the No&Vib fields. These courses are seen as suitable for sustainability and will be covered by the corresponding Report of the SENVIBE project associated with Task 8.7. Institutional sustainability.

At the completion date of this report, at the accredited state universities in Serbia, at the targeted study programmes in the field of technical and technological Sciences, 31 course was detected in basic academic studies, which directly, or at least to a non-negligible extent, deal with or contain aspects related to No&Vib and Technical Acoustics (type ii) of courses described above. It is important to point out that the vast majority of these courses are elective. Thus, it is not known how many of these courses have been attended by students, which puts an additional question mark about the level of education in the No&Vib fields in Serbia among undergraduate students. The educational system would certainly benefit if a larger number of these courses would be compulsory. A detailed overview of the courses whose contents include No&Vib (or their aspects) and which are taught at accredited state universities has been tabulated. In addition to the title of the courses, the table created contains the detailed content of the course, outcomes, methods of teaching, the name of the university and the faculty or the study programme, as well as the source used for this survey. It is worth analysing in the future of the SENVIBE project which of them can be modernized.

It should also be emphasized that a strikingly large number of directions and modules has been detected, where there are no courses dealing with the theme of No&Vib, although it is clear that by the nature of the study programme those courses should exist. For example, on accredited study programmes in the field of Traffic and Transport Engineering at the Serbian state university, there is no course in the basic studies on the subject. The absence of a subject is also apparent in the study programmes that have a large number of modules and are expected to deal with No&Vib, but they do not include them. Such are the modules of the University of Belgrade (Faculty of Civil Engineering, modules: Hydraulic and Environmental Engineering, Road, Railway and Airport Engineering, Management, Technology and Informatics in Civil Engineering, Structural Engineering) and modules of the University of Novi Sad (Faculty of Civil Engineering in Subotica, modules: Structures, Hydraulic and Water Engineering, Roads, Architectural Engineering, Geodesy). This finding also deserves attention in future activities of the SENVIBE project, at least to alert authorities about it, its potential consequences or previous likely effects.

At the completion date of this report, in the field of technical and technological sciences, only one mandatory subject has been detected in academic studies at private universities in Serbia, which is directly related to the field of No&Vib. The number detected is surprising and deserves the attention from related authorities.

Based on the online study guide of Acoustics in Europe, the existence of a relatively dense representation in Europe, especially in the northern and central continental Europe, has been noticed. It has been also found that there are countries in EU that have a continuous higher education that major in No&Vib/Acoustic and Vibration/Sound and Vibration through all three cycles, such as the UK and France. There are quantitative indicators for both of them implying that there is:

- very high interest among students to study these programmers;
- very high satisfaction of them with respect to what they acquired during studies;
- very high employability of them as researchers, technicians, engineers, and entrepreneurs, working in universities, companies, control offices, etc.

Three universities that offer representative undergraduate programmes in these fields have been analysed, two of which are from the countries mentioned previously (the UK and France) and one is from Denmark. All three representative undergraduate programmes have a high international reputation. They are carried out at: University of Southampton, Southampton, UK; University of Le Mans, Le Mans, France; and Technical University of Denmark, Lyngby, Denmark. Their structures have been analysed in details. In general, the first year provides a background in Physics and Mathematics and basics of Acoustics and Vibration. As the study continues, the level of specialization increases. This specialization is realized not only through the compulsory courses, but also via elective courses, a practically-oriented individual project and engineering-related work placements (internship). What is also striking is a very rich list of test facilities/pieces of equipment that students have at their disposal at these universities. Thus, establishing good and rich test facilities is one of the lessons learnt for Serbia and is also the fact to be presented to higher local, regional and national authorities. A list of courses related to No&Vib has been created for these three representative EU programmes. Besides for modernizing courses and modules during the SENVIBE project, they can be used for introducing new course in these fields in due course.

Prepared by

- **Dragana Strbac, Dragi Radomirovic, Miodrag Zukovic, Niksa Jakovljevic and Ivana Kovacic**

  Novi Sad, 31/12/2018

- **Zeljka Jelicic Marinkovic, Mira Pucarevic**
  Novi Sad, 01/01/2019

- **Milan Stojiljkovic**
  Novi Sad, 10/01/2019

Compiled by Hans Bodén
Stockholm 15/01/2019

Polished by Ivana Kovacic, Dragana Strbac, Neil Ferguson and Hans Boden
Novi Sad, 22/01/2019

Approved by Project Coordinator
Novi Sad, 22/01/2019

"*This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein*"

Co-funded by the Erasmus+ Programme of the European Union

SeNVIBe

APPENDIX I

SURVEY OF THE EDUCATION OF SELECTED UNDERGRADUATE ENGINEERING PROGRAMMES IN SERBIA AT PUBLIC UNIVERSITIES: COURSES RELATED TO THE NO&VIB FIELDS

University **Faculty** **Study program**	**Course**	**Course content**	**Educational outcomes/ Purpose**	**Teaching methods**	**Reference**	**Date**
University of Belgrade **School of Electrical Engineering** **Electrical Engineering and Computing; module Electronics/Telecommunications and Information Technology/ Master module: Audio and Video Communications**	Electroacoustics	Appearances in sound propagation: terms, reflection, acoustic impedance concept, diffraction. Hearing sense and human voice. Sound field in space: acoustical response, mathematical models. Electro acoustic converters: general theory, speakers, microphones. Subjective aspects of the sound field, acoustic in ecology.	Student will be able to understand problems which are resent when using electro acoustic devices in telecommunications and appearances in sound field. This is the basis for some other courses from audio system fields and multimedia telecommunications.	lectures, demonstrations, laboratory exercises	https://www.etf.bg.ac.rs/en/fis/karton_predmeta/13E033E	4.12.2018.

University of Novi Sad **Faculty of Technical Sciences** **Mechanical engineering/ Mechanization and Construction Engineering /Technical Mechanics and Technical Design /Production Engineering**	Theory of Oscillation	Linear and nonlinear spring. Free oscillations with one degree-of-freedom of motion. Equivalent rigidity. Kinetic and potential energy of the one degree-of-freedom system. Lagrange equations for motion of the one degree-of-freedom system. Riley`s procedure for determining circular frequencies. Curled and transversal oscillations of massive girders. Free oscillations with viscous friction force and sliding force in the one degree-of-freedom system. Forced oscillations in the one-degree-of-freedom system. Forced oscillations under Dirak and Heaviside forces. Kinetic and potential energy of the two degree-of-freedom system. Lagrange motion equations for the two degree system. Integration of the motion equation of the two degree-of-freedom system. Forced oscillations of the two degree-of-freedom system. Resonance. Dynamic buffer. Influence of viscous friction on small oscillations in the two degree-of-freedom system. Definition on the stability of motion. Transversal oscillations of a string. Longitudinal oscillations of a beam. Curled oscillations of a beam. Transversal oscillations of a beam. Critical speeds of elastic shafts. Laval`s paradox.	To acquire knowledge necessary for a modern mechanical engineer.	Lectures and practice.	http://www.ftn.uns.ac.rs http://www.ftn.uns.ac.rs/n546274806/theory-of-oscillation	26.11.2018.

University of Novi Sad **Faculty of Technical Sciences** **Mechanical engineering**	Noise, Vibration and Design	The concept of sound and noise. Propagation of sound waves. Plane waves. Spherical waves. Sound intensity and sound pressure. Acceptable sound pressure level from the noise. Acoustic impedance. Sound power levels of noise sources and characteristics. Diffraction and reflection of sound. Noise spectrum. Acoustics of enclosed space. Absorption characteristics. Reverberation time. The size, shape and design of the rooms as the acoustic parameters. Noise isolation. Transmissibility. Vibration isolation. Technical measures of protection against noise and vibration. Active methods of protection. Passive methods of protection. Identification of noise sources.	Creating a deep insight into the phenomena related to noise and vibration, training students to recognize and detect them as well as to remove or control unwanted consequences.	Lectures with presentations and animations. Auditory exercises. Consultation. Continuous monitoring of the level of students' knowledge through four tests (mandatory). Examination.	http://www.ftn.uns.ac.rs http://www.ftn.uns.ac.rs/n1998577603/noise--vibration-and-design	26.11.2018.
University of Novi Sad **Faculty of Technical Sciences** **Environmental engineering**	Introduction and Principles of Environmental Protection	Introduction to Environmental Engineering as a discipline (environmental crisis, the symptoms of the environmental crisis, new dimensions of the environmental crisis, the goal of environmental engineering, sustainable development, interdisciplinary and global approaches). Basic concepts of general environmental engineering (the concept of system, system boundaries, energy and matter exchange through the boundaries of the system, the Earth as a system, flows, cycles and structures of living systems in environment, the structure of an open environmental system). Water cycle and global cycles of some chemical elements (Water cycle, chemical elements, circuits, the global carbon cycle in nature, the global sulfur cycle in nature, global nitrogen cycle in nature). Mutual influence of	Acquiring Knowledge of the basic principles of environmental protection required for the profession. Knowledge of basic terminology and principles of environmental protection, necessary for further study and work in the field of environmental engineering.	Lectures. Auditory exercises. Consultation.	http://www.ftn.uns.ac.rs/883986083/introduction-and-principles-of-environmental-protection	24.12.2018.

		civilization and the environment (the development of cities, demographic explosion, nutrition of the population). The atmosphere, important parameters of the atmosphere and MAC pollutants in the atmosphere (the structure of the atmosphere, the temperature in the atmosphere). Noise as a specific type of pollution (production of sound and its transmission, sources of noise, permitted levels of environmental noise). Sources, characteristics and effects of pollution (air pollution, sources of polluted air, primary and secondary air pollutants, the effects of air pollution, ozone as a problem in the environment, global heating). Basic principles of environmental protection. The exercises are examples of the computation tasks which illustrate topics covered in theoretical teaching, contributing to a better definition, better observation and better understanding of the topics treated in the theoretical teaching.				
University of Novi Sad **Faculty of Technical Sciences** **Environmental engineering**	Acoustics and Noise Protection	The physical characteristics of sound (the rules for the production and propagation of sound waves). Audible range and limit of the risk of damage to hearing (ear sensitivity, phone and dB(A)). Room acoustics (absorption/reverberation – impact on the level and speech intelligibility). Devices for recording and reproductions of sound (microphones, loudspeakers, headphones). Audio systems for recording of audio signals (selection and placement of microphones for recording of speech, music and noise). Basic characteristics of the noise and its impact on humans	Students will learn how sound waves are produced and how they propagate. They will acquire basic knowledge about noise and its characteristics and impact on humans. In addition to basic elements of physical and physiological acoustics (what and how human can hear), students learn	Lectures are conducted using Power Point presentations available to students in .pdf format. Presentations with specially created audio and video clips and animations demonstrate and illustrate key details in the	http://www.ftn.uns.ac.rs http://www.ftn.uns.ac.rs/n534212256/acoustics-and-noise-protection	1.12.2018.

		(level, spectrum and temporal character). The noise from multiple sources (equivalent and authoritative level, overall, specific and background noise). The regulations on permissible noise level in the working and living environments, regulations and standards (dB(A) and N-curves, the impact of noise on certain activities, permitted noise dose during working hours). Measuring equipment and tools for noise analysis (sound level meters, filters, dosimeters, software tools). Environmental noise (traffic, construction and communal noise; sources and routes of noise transmission; methods of measuring and noise protection). Noise in the workplace (acoustic power, methods of measuring noise in the working environment, control measures and the protection of workers). Noise control (prevention at source (technical and legal means), control of the transmission lines, and protection of the receipt). Building acoustics (insulation material power, roads of penetrating noise, structural noise). Sound insulation (materials and structures, measurement of sound insulation of wall, floor and ceiling, windows and doors; regulations and standards, methods to improve the sound insulation). Prevention and protection from noise (acoustic barriers, sound absorbers, acoustic treatment of rooms and noise insulation, personal protection, active noise cancelling).	about the standards and regulations on permissible noise levels. At exercises they gain practical experience with measurement devices and techniques of measurement, monitoring and noise protection. Students will learn how to measure noise, room acoustic parameters, as well as insulation power. They will be able to identify and qualify potential problems with noise and suggest solutions for noise control and noise protection both indoors and outdoors.	lectures. The first part of the course (acoustics) is followed by auditory exercises. The second part of the course (noise protection) is followed by exercises in the Laboratory of Acoustics and Speech Technologies at FTN. Visits to several companies and institutions in Novi Sad are arranged, where students will learn about the measurement devices and software for noise analysis, as well as the techniques of measurement, monitoring and noise protection. The students will write a midterm paper, whose defense is one of the exam prerequisites.		

				Independent student work is supported through the web portal of the Chair of Telecommunications and Signal Processing - www.ktios.net.		
University of Novi Sad **Techical faculty "Mihajlo Pupin" (Zrenjanin)** **Environmental engineering**	Protection Against Noise and Vibrations	Theoretical and practical study: Definitions of the sound, sound wave, and noise; spreading of sound wave and sound field. Definitions of the sound pressure, sound intensity, and sound power. Fundamentals of physiological acoustics; equivalent levels of audibility; subjective feeling of sound pressure; relative volume; sound and phone levels. The physiology of sound receiving organs; impairment and disruption of normal perception of sound. Definition of the noise of technical systems and standard methods for experimental determination of its levels. Definition of communal noise in the working and living environments (equivalent levels, etc.) and experimental determination of its level. Legislation in the field of noise of technical systems; the ways of solving problems of noise in industry; the way of solving the problems associated with environmental noise and pollution by noise. Theoretical basis of vibrations; the concept of degree of freedom; system vibration and single-degree of freedom;	The targeted outcome to be achieved by the course "Protection against noise and vibrations" is that students gain the necessary practical and theoretical skills which enable them to perform independently: quantification of the level of noise and vibrations, application of the methods of their control, as well as solving the problems associates with noise and vibrations in working and living environments.	Lectures are conducted ex-cathedra, and exercises in direct work with students. Exercises are focused on solving concrete tasks from monitoring noise and vibration as in the "Practical teaching" section.	http://www.np.ac.rs/ http://www.np.ac.rs/downloads/knjige_predmeta/eng/avt_coursebook.pdf	30.11.2018.

		concept of power system frequency; damping and modes of oscillation; system response to stimuli and experimental methods determination of system response. A harmonized system of declaring vibration levels of hands, arms, and human body. The permitted levels of vibrations and the corresponding legislation. The methods of reducing vibrations in order to reduce the level of human exposure to harmful vibrations.				
University of Nis **Faculty of Occupational Safety** **Occupational Safety**	Noise and Vibrations	Vibration: Basic terms and quantities for describing vibration. Vibration kinematics and dynamics. Fundamental principles of vibration generation and transfer. Fundamental principles of anti-vibration foundation. Effects of vibration on humans. Vibration of the hand-arm system. Vibration transferred onto humans. Wave equation. Wave types. Sound field types. Basic noise types. Classification according to time and frequency character of noise. Basic terms and quantities for describing noise. Outdoor generation and propagation of noise. Point sources of noise. Sound pressure, intensity, and strength. The term, addition, and subtraction of noise level. Subjective assessment of noise intensity. Energy physiological quantities. Indoor generation and propagation of noise. Noise level in diffuse sound field. Reverberation time. Noise level in spaces with high absorption coefficient. Sound isolation. Mechanisms of hearing organs and sound perception. Effects of noise on humans. Noise and vibration measurement. Measuring chain and	Acquiring theoretical knowledge in mechanical and acoustic oscillations. Enabling students to identify the phenomena of noise and vibration in the occupational environment, to identify and characterize noise and vibration sources, to assess noise and vibration affecting workers, and to apply acquired knowledge to occupational safety engineering. Learning outcomes: understanding physical laws of generation and propagation of mechanical and sound waves,	Lectures and laboratory work	https://www.ni.ac.rs/en/studies-and-admission/studies/course-catalogue/courses/category/227-occupational-safety	26.12.2018.

		basic measuring parameters. Selection of measuring points. Indicators of noise and vibration affecting humans. Allowed values. Noise and vibration assessment. Standards and regulations. Calculus problems in noise and vibration. Measurement in the field provides students with practical skills for basic measurement, calculations, and analyses of obtained experimental results.	calculating indoor and outdoor noise level, calculate energy physiological quantities, measuring, analyzing, and assessing vibration affecting humans; implementing current standards and regulations.			
University of Nis **Faculty of Occupational Safety** **Environmental Protection**	Environmental Noise	Wave equation. Wave types. Sound field types. Basic noise types. Division according to time and frequency of noise. Basic terminology and physical quantities for noise description. Outdoor noise generation and propagation. Point sources of noise. Sound pressure, intensity, and strength. Term, addition, and subtraction of noise levels. Subjective evaluation of noise strength. Energy physiological quantities. Indoor noise generation and propagation. Noise level in a diffuse sound field. Reverberation time. Noise level in spaces with high absorption coefficient. Sound isolation. Environmental noise sources – basic characteristics. Mechanisms of hearing organs and sound perception. Effects of noise on humans. Noise measurement. Measuring chain and basic measuring parameters. Selection of measuring points. Noise indicators. Allowed values. Noise assessment. Standards and regulations. Calculus problems in noise and vibration. Measurement in the field provides students with practical skills for basic	Acquiring theoretical knowledge in the field of acoustic oscillations. Enabling students to identify the phenomenon of environmental noise, identify and describe environmental noise sources, and to evaluate noise and apply the acquired knowledge to the field of environmental engineering. Learning outcomes: understand physical laws of sound wave generation and propagation, calculate indoor and outdoor noise levels, calculate energy physiological quantities, measure, analyse, and asses noise level conditions;	Lectures, exercises, consultations, graphic works	https://www.ni.ac.rs/en/studies-and-admission/studies/course-catalogue/courses/category/228-environmental-protection	26.12.2018.

		measurement, calculations, and analyses of obtained experimental results.	and implement current standards and regulations.			
University of Nis **Faculty of Civil Engineering and Architecture** **Civil Engineering**	Structural Stability and Dynamics	The equations of the theory of finite deformation and second order theory. Linearized second order theory. The concept and formulation of stability criteria. Differential equations of the right rod at the second order theory and its solution. The method of initial parameters. Application of Methods of deformation. Buckling in plastic area. Dynamic load and dynamics methods of construction. Oscillation system with continuously distributed mass. Free and forced vibrations with one degree of freedom. Free and forced vibrations with several degrees of freedom. Introduction to Engineering Seismology. Calculation of buildings and engineering structures to earthquakes according to our regulations and Eurocode 8. Application of modern computational programs for the analysis of structures under seismic effects.	That student can practically apply the acquired knowledge in solving problems of the second order theory, the problems of structural stability and implementation of structural dynamics in engineering and manufacturing seismic analysis of engineering structures and buildings in practice.	Lectures, exercises, consultations, graphic works	https://www.ni.ac.rs/en/studies-and-admission/studies/course-catalogue/courses/category/843-building-construction	25.12.2018.

University of Nis **Faculty of Civil Engineering and Architecture** **Civil Engineering**	Structural Dynamics with Earthquake Engineering	Practice accompanies lectures and exercise program is the same program of lectures. The exercises are performed numerical examples, a prominent example of graphic works, graphic works and test tasks.	To learn about the dynamic loads, as well as to master the basic knowledge necessary for the calculation of engineering structures under dynamic loads, especially seismic loads.	Lectures, exercises, consultations, graphic works	https://www.ni.ac.rs/en/studies-and-admission/studies/course-catalogue/courses/category/845-structural-engineering	24.12.2018.
University of Nis **Faculty of Electronic Engineering** **Electrical Engineering and Computing**	Acoustics	Sound as a phenomenon. Characteristics of sound field. Sound waveguides. Plane and spherical waves. Sound sources. Electro-acoustic transducers (microphones, headphones and loudspeakers)-construction, working principles and characteristics. Analogies. Room acoustics (wave, statistical, and geometrical theory). Physiological acoustics (auditory system function). Psychological acoustics (subjective effects of sound). Generation and characteristics of speech and musical signals. Noise. Recording, storage and reproduction of audio signals. Acoustic and audio signal processing.	Acquiring basic theoretical and practical knowledge about sound, its generation and transmission, sound sources, transducers, room acoustics, acoustic signals, sound perception and its consequences. Theoretical knowledge in the field of sound; Application of theoretical knowledge in analysis, modeling and design of acoustical systems and systems containing acoustic components, acoustic design and sound insulation. Adequate usage of	Lectures, exercises, laboratory exercises, exercises in a studio, consultations	https://www.ni.ac.rs/en/studies-and-admission/studies/course-catalogue/courses/category/661-telecommunications	25.12.2018.

			acoustic components and equipment.			
University of Nis **Faculty of Mechanical Engineering** **Mechanical Engineering**	Mechanics IV - Theory of Vibration	Modeling of single degree-of-freedom (SDOF) systems. Springs in combination. Viscous damping. Energy dissipated by viscous damping. Static deflections and gravity. Small angle or displacement assumption. Equivalent systems method. Standard form of differential equation. Free vibrations of undamped system. Critically damped free vibrations. Over damped free vibration. Forced response of an undamped system due to a single-frequency excitations. Forced response of a viscously damped system subject to a single-frequency harmonic excitation. Two degree-of-freedom systems. Natural frequencies and mode shapes. Free response of undamped systems. Free vibrations of a system with viscous damping. Dynamic vibration absorbers. Forced vibrations of two degree-of-freedom systems. Vibrations of continuous systems. General method. Second-order systems: Strings, Bars and Shafts. Transverse beam vibrations.	Students' ability to model and solve specific technical problems.	Lectures, exercises, laboratory exercises, homework, colloquiums	https://www.ni.ac.rs/en/studies-and-admission/studies/course-catalogue/courses/category/848-mechanical-engineering	25.12.2018.

University of Kragujevac **Faculty of Engineering** **Applied mechanics and automatic control/ Mechanical Engineering**	Sensors and Actuators	Introduction. Terminology. Structures of systems that include sensors and actuators. Static and dynamic characteristics of sensors and actuators. Criteria for selection of sensors. Systems for acquisition and data processing. Measurement of movement, velocity, acceleration, vibration. Measurement of force and tension. Measurement of pressure. Measurement of temperature. Actuators. Electromechanic actuators. Electro-magnets. Electric motors. Hydraulic actuators. Hydraulic components. Functional and technical characteristics. Pneumatic actuators. Pneumatic components. Functional and technical characteristics. Non-conventional actuators. Actuators as components of systems. Diagnostics of failure of sensors and actuators.	Understanding of structure, model, general characteristics, functioning principles and implementation of representative categories of sensors and actuators.	Teaching with ex-cathedra approach with multimedia presentations and interactive work with students. Auditoria exercises combine ex cathedra approach and computer tools. Laboratory exercises refer to fields of implementation of sensors and actuators.	http://www.mfkg.rs/eng/sajt/Downloads/Studije/Akreditacija/Osnovne/M5/Obavezni/bm6251_sensors_and_actuators.pdf	24.12.2018.

University of Kragujevac **Faculty of Engineering** **Applied mechanics and automatic control/ Mechanical Engineering**	Machine Dynamics	Theoretical study. Experimental determination of centroid location and moment of inertia. Balancing of planar mechanisms, Balancing of rigid rotors; single plane and two-plane balancing; analytical and experimental field balancing methods, Balancing of multicylinder engines, Elastodynamic analysis of the high speed mechanisms, machines vibrations. Isolation of vibrations. Practical classes. Measurement of the moment of inertia, Balancing of rotors in its own bearings.	By the end of this course, students should be able to determine the moment of inertia of a body, to determine imbalance and balancing of mechanisms, rotors, and multicylinder engines, to solve problem of machines vibration isolation.	Lessons, auditory and laboratorial classes, independent work.	http://www.mfkg.rs/eng/sajt/Downloads/Studije/Akreditacija/Osnovne/M5/Izborni/bm6351_machine_dynamics.pdf	24.12.2018.
University of Kragujevac **Faculty of Engineering** **Road traffic/ Mechanical Engineering**	Testing of Motor Vehicles and Engines	Theoretical study. Measuring principles, characteristics of measuring components for vehicle testing, structures of experimental systems, methods, experimental installations and types of testing of vehicles aggregates and systems, testing of functional characteristics of engine, testing of main clutches and gearboxes, testing of articulated couplings and power trains, testing of suspension systems and carrying structures; testing of complete vehicle, identification of the parameters influencing the vehicle performance, testing of vehicle performances, testing of vehicle drivability, testing of vehicle vibration processes, measurement of vehicle noise levels.	Based on acquired knowledge, students should know to select adequate measuring equipment for concrete testing task, to form a measuring chain, to conduct the measurements, to record the measuring signals for further analyses and use.	Lectures, exercises	http://www.mfkg.rs/eng/sajt/Downloads/Studije/Akreditacija/Osnovne/M8/Izborni/bm6432_testing_of_motor_vehicles_and_engines.pdf	24.12.2018.

University of Kragujevac **Faculty of Engineering** **Automotive engineering**	Sustainable Development of Motor Vehicles	Natural resources and their reserves. The influence of the preparation of materials for the production of vehicles on the environment. The influence of vehicle production on the environment. The content of exhaust gases of the vehicle. The influence of vehicle use on the environment. "On-board" diagnostics in the function of reducing pollution from the exhaust gases of the vehicle. Traffic noise and vehicles. Recycling of motor vehicles. Legislative acts.The emission from vehicles with petrol, gas and diesel engines will be practically measured. Withi-the-framework of the study research work, students will be trained in basic field research and performing environmental impact analysis of vehicles.	After successful completion of the course, the student: (1) recognizes the influence of vehicle production on the environment, (2) knows the effect of using the vehicle on the environment, (3) knows the importance of on-board diagnostics on the quality of exhaust gases of the vehicle, (4) knows the basics of recycling vehicles, (5) know basic standards in the field of ecology of motor vehicles.	Interactive at lectures and exercises, writing two seminar papers. The final seminar paper involves making a presentation of the previous two papers and a public defense of the same.	http://www.fink.rs/images/stories/PDF/2018_nove_knjige_predmeta/23.10.2018/Prilog_5.2_Knjiga_predmeta_Automobilsko_inzenjerstvo_OAS_3.pdf	09.12.2018
University of Kragujevac **Faculty of Mechanical and Civil Engineering.** **Mechanical Engineering**	Maintenance & Diagnostics	Models of maintenance and analysis of application possibilities. Defining parameters for monitoring the quality of maintenance and condition of equipment. Diagnostic methods, devices and their specific application. Organization, information system, planning and effectiveness of the maintenance process. In laboratories and enterprises in the region, diagnostic measurements of vibrations, noise, SPM, temperature, geometric accuracy are performed and real reports with state estimates are made.	Ability to identify, define and solve engineering problems in the field of maintenance and diagnostics, and develop the ability to use modern diagnostic equipment.	Lectures, auditory and laboratory exercises. Visits to local enterprises.	http://www.mfkv.kg.ac.rs/documents/knjiga-predmeta/oas-mi-knjiga-predmeta-2014.xls	09.12.2018

University of Kragujevac **Faculty of Mechanical and Civil Engineering.** **Mechanical Engineering**	Vibration of Mechanical Systems	The concept of oscillation. Classification of oscillatory processes and systems. Linear oscillatory systems with a finite number of degrees of freedom. Linearization of differential equations of motion. Stability of mechanical system balance. Free oscillations of linear conservative systems and linear systems with dissipation. Forced oscillations of linear systems. Oscillations of linear systems with distributed parameters: free longitudinal, torsional and transverse oscillations of a constant cross-section rod. Engineering applications.	By acquiring the necessary knowledge of the oscillatory processes of linear mechanical systems with finite number of degrees of freedom and distributed-parameter systems, students will be able to solve oscillatory problems from the domain of road and railway vehicles, robotics, dynamics of machines, mechanisms, mining and construction machines and devices.	Lectures, auditory exercises.	http://www.mfkv.kg.ac.rs/documents/knjiga-predmeta/oas-mi-knjiga-predmeta-2014.xls	09.12.2018
University of Kragujevac **Faculty of Mechanical and Civil Engineering.** **Mechanical Engineering**	Dynamics of Machines	Basic terms, concepts and definitions. Dynamic drive models. Differential equations of motion of machines and mechanisms. Modes of motion. Transient processes. Basic concepts and methods of vibrating machines. Principles of active and passive vibration isolation. Linear vibrators. Dynamic oscillation absorbers. Impact oscillators. Vibration machines and their use in technology. Balancing the rotational parts of machines. Static and dynamic balancing. Friction in kinematic pairs of mechanisms. Friction angle and friction circuit in kinematic pairs. The occurrence of self-locking and sticking (locking) in the mechanisms as a result of friction. Dynamics of machines and mechanisms with elastic members. Elastic shaft with	By mastering the necessary knowledge in the dynamics of the machines, students will be able to apply the existing analytical methods and modify them in accordance with the nature of concrete problems in the domain of machine dynamics using program packages for symbolic and numerical analysis and to successfully follow new	Lectures, auditory exercises.	http://www.mfkv.kg.ac.rs/documents/knjiga-predmeta/oas-mi-knjiga-predmeta-2014.xls	09.12.2018

		an ideal central disc. Elastic shafts with an eccentric drive. Critical shaft speeds. Influence of the gyroscopic effect at critical speeds. Elastic multi-disc shaft. Dynamics of mechanisms with variable mass of members.	achievements in this field of technique			
University of Kragujevac **Faculty of Mechanical and Civil Engineering.** **Mechanical Engineering**	Measurement Techniques	Basic Measurement: Measurement Errors; Static and Dynamic Characteristics of Measuring Systems; Converters Used in Mechanism for Measuring Distance, Acceleration, Angle, Speed, Acceleration, Deformation, Force, Moment, Power, Pressure, Level, Flow and Fluid Temperature. Laboratory exercises examining the characteristics of first and second-order converters in the example of temperature and force converters and demonstrating measurements with an accelerometer, a noisemeter and a 3D scanner.	The student is familiar with the structure of digital measurement systems, as well as working principles, static and dynamic characteristics of converters used in mechanical engineering.	Lectures, auditory and laboratory exercises.	http://www.mfkv.kg.ac.rs/documents/knjiga-predmeta/oas-mi-knjiga-predmeta-2014.xls	09/12/2018
University of Kragujevac **Faculty of Mechanical and Civil Engineering** **Mechanical Engineering**	Noise Protection	Physical and physiological noise concepts, noise measurements, indoor noise, communal noise, noise forecasting models, noise estimation and noise control.	Broad education, necessary for analyzing and understanding of existing engineering solutions in the field of environmental protection. Ability to design a noise protection system using a methodology learned at the course itself as well as at some of the previous	Lectures, laboratory and field exercises.	http://www.mfkv.kg.ac.rs/documents/knjiga-predmeta/oas-mi-knjiga-predmeta-2014.xls	09.12.2018

			courses. Ability to work in multidisciplinary teams.			
University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Civil Engineering**	Basics of Environmental Engineering	Through this course, students will be introduced to the basic concepts and principles of ecology, the environmental protection and ecological factors, their classification, then geoetics, forms of pollution and environmental protection in general. Basic principles of ecological engineering, business design. Planet Earth - global environmental problems. Pollution and protection of soil, creation, characteristics, manner and types of pollution. Pollution and water protection. Natural pollution, pollution of surface, groundwater, industrial waters. Pollution and air protection. Air pollutants with production activities, combustion of fossil fuels, sources and classification. Radioactive contamination and protection. Noise and Noise Protection. Monitoring, models of transport of pollution. Municipal solid waste management: collecting, sorting recycling. Hazardous medical waste. Utility solid waste depot. Industrial waste management Legal regulations in the field of environmental protection. National regulations. EU Directive. Education in the field of environmental protection. Local environmental action plans. The role of NGOs.	Students who successfully pass the exam will have an ecological way of thinking, which will thus become the basis for later behavior and attitudes towards the environment and nature as a whole. The student will be able to critically reflect on existing problems in the context of an engineering approach to nature conservation from the aspect of environmental protection.	Lectures, exercises.	https://drive.google.com/file/d/0B_Hn-Zw3UTaudjVZU0N2QkZPV28/view	09.12.2018

University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Civil Engineering**	Building	Defining the field of building. Building set. Massive buildings. Skeletal buildings. Foundations. Intermediate structures. Non-constructive elements. Stairs. Roofs. Insulations. Hydro isolation. Thermal isolation. Acoustic insulation. Fire protection. Open. Windows and doors. Chimneys and ventilation channels. Contemporary tendencies in building. Technical documentation.	Student's ability to draw and read architectural plans.	Lectures, exercises, fieldwork, consultations, project.	https://drive.google.com/file/d/0B_Hn-Zw3UTaudjVZU0N2QkZPV28/view	09.12.2018
University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Electrical and Computer Engineering**	Electroacoustics	Basic features, Sound waves propagation. Sound propagation phenomena, sound sources and obstacles in sound propagation. Analogies between acoustic, electrical and mechanical systems. Room acoustics (definition of wave mode, reverberation time, absorption, wave energy in the room). Physiological acoustics (vocal tract, ear as sound wave receivers, subjective measurements of the sound and their properties). Microphones (types, characteristics, properties). Speakers (types, characteristics, features). Headphones, stereophonic transmission. Quantization of audio signals. Jitter. Alliasing. Theoretical and real audio signals dynamics. A/D and D/A converters of audio signals. Oversampling. Noise colouring. Digital filters. Channel codes. Reduction and compression of data flow. Multichannel systems for audio compression in transmission and storage. Data transmission protection. Optical and magnetic-optical sound recording. CD, MOD, DVD. Computer as a device for recording and generating sound signals.	A student will be able to model acoustic systems for recording, processing and reproduction of sound phenomena in different sound conditions on its own, as well as to analytically examine electroacoustic devices.	Lectures, auditory exercises, laboratory exercises, consultations, homework assignments and written exam.	https://drive.google.com/file/d/0B_Hn-Zw3UTaudGdHQ3BrdmxmSVU/view	09.12.2018

		Professional codes for connecting devices. Digital audio mixer tables. Sound system design for rooms, churches, halls, theaters, cinemas, squares and stadiums. Characteristics of noise and vibration. Psychoacoustic noise criteria. Vibration and impact characteristics. Measuring vibration and shock. Measuring instruments. Numerical exercises describing free space acoustic phenomena and modeling acoustics point source in MATLAB. Numerical exercises describing the absorption and reflection of sound, as well as the image model of multiple source models. Modeling acoustic systems using analogies between acoustic electrical and mechanical systems. Modeling of sound propagation in enclosed space. Subjective and objective measurer of sound level in acoustic systems. Modeling of acoustic systems with microphones. Modeling of acoustic systems with speakers. Headphones and stereophonic transmission. Speech and audio signal compression. Sound system design of rooms, churches, halls, theaters, cinemas, squares and stadiums. Noise and vibration characteristics.				

University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Environmental Engineering and Occupational Safety**	Protection Systems in Mining	Contemporary principles for the implementation of occupational safety and health. Injuries at work and occupational diseases. Basic sources of obsession in mining and technical protection measures. Gases in the mining atmosphere. Mineral dust in the mining environment. Noise and vibration. Mines climate and its control. Lighting in the mines. Personal protective agents and their application. Technical measures of protection in underground exploitation. Dynamic phenomena in mines. Technical measures for protection in surface exploitation. Aerospace surveying. Hazards and fire protection measures. Explosions in the mines. Rescue service in mines. Law regulation. Manner of keeping records and statistics of injuries and occupational diseases. Laboratory and portable instruments for measuring the concentration of gases. Methods and instruments for measuring the concentration of mineral dust in the atmosphere of the working environment. Methods and instruments for assessing the condition of the climate factors of the working environment. Methods and instruments for measuring noise and vibration in working environments. Fire extinguishers and fire extinguishers. Suffering to protect the respiratory organs. Methods of early detection of endogenous fires. Methods and procedures for preventing the formation and spreading of explosions in mines. Plan for defense and rescue in mine mines.	Training for identifying and assessing hazards. Ability to record and analyze injuries and occupational diseases. Training for measuring and concentration of gases and planning of protection measures. Ability to measure concentration of mineral dust and planning protection measures. Training for assessing the climate of the work environment. Ability to measure noise and vibration and planning protection measures. Training for the use of respiratory protective devices. Knowledge of the principles of organizing technical protection in technological systems of exploitation, preparation and processing of mineral raw materials.	Combined ex-chatedra with multimedia presentation and interactive teaching with IT support.	https://drive.google.com/file/d/0B_Hn-Zw3UTauaW93NTBpWFVBdVk/view	09.12.2018

University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Environmental Engineering and Occupational Safety**	Noise and Vibrations	Basic principles of vibration isolation Vibration absorption Vibration isolation Elements and materials for vibration absorption and vibration isolation Vibration isolation system calculation Machine vibration monitoring diagnostics Diagnostic tools FFT, CPB, Kepstrum, Envelop, Order analysis Conclusion on the condition of certain machine parts and machines as a whole Assessment of the state of vibrations Allowed values Application of personal protective devices Wave equation - forms and solutions Wave types - flat, spherical and cylindrical State of noise levels in the working environment Noise sources and their characteristics Models for the forecast of noise indoors, model structure, noise control, basic principles, sound absorption and sound insulation, noise control elements and materials, noise source control, source leakage, control of transmission paths, screen display, on-site inspection, application of personal protective equipment Measurement and analysis noise and vibration. Choice of parameters for analysis. Frequency analysis. Types of frequency analysis. FFT analysis. Clarified analysis. Octane and tertiary analysis. Frequency analysis methods. Correlation analysis. Kepstrum and order analysis. Distribution of signals by time and frequency character. Measuring instruments. Types and types of instruments. Basic measuring chain. Converters - condenser microphones and accelerometers: principle of operation, choice of f.625 0 types and	Knowing the legal regulations related to measurement and evaluation of noise and vibration. Training for noise measurement, interpretation in the processing of results. Ability to plan measures against excessive noise. Skills for vibration measurement, interpretation and processing of results. Ability to plan vibration protection measures.		https://drive.google.com/file/d/0B_Hn-Zw3UTauaW93NTBpWFVBdVk/view	09.12.2018

		sizes. Setting the accelerometer. Detector signal. Calibration of measuring system. The impact of the environment on the measurement. Shittiners. Standards and Regulations. European directives. Basic elements of the measuring procedure: selection of measuring point, measuring interval, measuring parameter, measuring chain. Processing results. Procedures and standards for determination of sound power of sources and sound insulation of partition structures. Procedures and standards for measuring NA and WB vibrations. Legislation related to measurement and evaluation of noise and vibration. Measurement procedures, selection of measuring points, interpretation and processing of results, preparation of reports. Practical noise measurement. Noise management - measures and procedures for its limitation: barriers, personal protective equipment. Vibration Measurement Procedures, Selection of Measuring Points, Interpretation and Processing of Results to Reports. Practical vibration measurements. Measures and procedures for limiting vibrations, constructive measures, personal protective equipment.				
University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences**	Occupational Noise and Vibrations Protection	Vibrations as a physical phenomenon. Consequences of vibration effects. Application of personal protective equipment. Measuring vibration of equipment for work. Instrumentation for vibration measurement. Basic principles of vibration isolation. Protection against vibration and equipment for work.	Knowing the physical principles of vibration and noise generation. Skills: measurement of noise levels in the work environment and vibration of	Lectures, exercises and consultations.	https://drive.google.com/file/d/0B_Hn-Zw3UTauaW93NTBpWFVBdVk/view	09.12.2018

Environmental Engineering and Occupational Safety		Vibration protection in motor vehicles. Human body vibration and vibration transmission over hands and arms. Noise as a physical phenomenon. Effects of noise. Application of personal protective equipment. Measurement and Noise Analysis Methods in the workplace. Noise measurement instrumentation. Measure and analyze the soundness of equipment for work. Measurement of the noise of motor vehicles. Reducing the risk of noise and vibration. Noise protection in motor vehicles.	equipment for work. Diagnostic purposes. Application of methods for controlling noise and vibration.			
University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Mechanical Engineering**	Vehicle Dynamics	An extract from car history. - Introduction to vehicle dynamics. Basic concepts from statics. The forces and moments that affect the vehicle. Degrees of freedom and vehicle oscillations. Oscillatory vehicle model. Oscillations of motor vehicles - theoretical basis. Free unshifted oscillations with one degree of freedom. Forced silenced oscillations with one degree of freedom. Vertical reaction. Initiation of uneven substrate. Harmonious initiative. Periodicals initiative. Stochastic Initiative. Characteristics and analysis of oscillatory quantities. Calculation of oscillatory characteristics. Oscillatory characteristics of the vehicle. Deformation of elastic elements. Axial pressure. Vertical oscillations with two degrees of freedom. Influence of oscillations on man. Reflection and observations. Evaluation of the oscillation effect. Evaluation of the effect of oscillation on man. Evaluation and optimization of the oscillation effect. Recommendations. Time of exposure to oscillations. Management and	The student's ability to routinely use acquired knowledge and skills in vehicle dynamics, and to look at their place in team work and to improve themselves.	Lectures, exercises and consultations.	https://drive.google.com/file/d/0B_Hn-Zw3UTauUE50OUJnb2FFMjg/view	10/12/2018

		manageability. Turning at low speed. Turning at high speed. Equations of turning. Gradient of disposability. Characteristic speed. Critical speed. Increase of lateral acceleration. Increase in turning speed. Side skating angle. Static reserve. Braking of motoric vehicles. Basics. Work and braking power. Brake wheel. Gripping and slipping. Braking stability. Maximum braking performance. Real braking characteristics. Distribution of braking forces. Modern electronic systems for controlling the dynamic behavior of vehicles. Theory of impact and collision of a vehicle. Basic equations of shock theory. General laws of the theory of impact. Punching the body into a stationary obstacle. Proper central collision of two bodies. Loss of kinetic energy in a plastic collision - Karno's theorem. A hit on the body that turns. Non-centralized collision of a vehicle in straight motion. Collision modeling.				

University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Mechanical Engineering**	Oscillation Theories	Small oscillations of a single oscillation system. Simple harmonic oscillation. Harmonic oscillator. Riley's method of energy. Reducing the mass and stiffness of the springs. Equivalent models. Curved-path harmony oscillation. Mathematical pendulum. Cycloid pendulum. Physical pendulum. Roller pendulum. Torsion oscillator. Oscillations with friction. Resistance proportional to the first degree of speed. Decaying oscillatory motion. Aperiodic movement. The function of dissipation. Free forced oscillation without resistance. Free forced oscillation with resistive force. Complex forced oscillations. The case of periodic disturbance. The case of arbitrary disturbance. Small oscillations of systems with multiple degrees of oscillation. Small oscillations of the holonomic conservative system. Differential equations. Characteristics of inertial and quasielastic coefficients. Frequency equation. Orthogonality of major oscillations. Main and normal coordinates. Forced oscillations. Dynamic absrorbers. Linear oscillations of a system with several degrees of freedom. Non-homogeneous chains. Homogeneous chains. Trigonometric method. Small torsional oscillations of light shafts with multiple disks. Reducers. Small transverse oscillations of elastic beams with more concentrated masses. Approximate methods for determining natural circular frequencies of oscillatory systems. Dankerle's method. Morley's method. A complex pendulum. Oscillations of the vehicle. Small	Mastering basic concepts and methods of linear theory of oscillations of mechanical systems with arbitrary finite number of degrees of freedom and elastic bodies with one-dimensional mass distribution, using appropriate computer tools.	Lectures, exercises and consultations.	https://drive.google.com/file/d/0B_Hn-Zw3UTauUE50OUJnb2FFMjg/view	10.12.2018

		oscillations of a non-conservative system. Characteristic equation of small oscillations of a non-conservative system. Stability of motion. Lieutenant DiRichle's theorem. Stability and instability of oscillatory systems. Hurricht criterion stability. Oscillations of elastic bodies. Wave equation. Transverse oscillations of the wire. Bernoulli's method of particular integrals. Longitudinal oscillations of prismatic beams. Torsional oscillations of circular shafts. Free transverse oscillations of single beam beams.				
University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Mining engineering**	Technical Protection	Contemporary principles for the implementation of occupational safety and health. Injuries at work and occupational diseases. Basic sources of obsession in mining and technical protection measures. Gases in the mining atmosphere. Mineral dust in the mining environment. Noise and vibration. Mine's climate and its control. Lighting in the mines. Lightning protection of assets and their application. Technical measures of protection in underground exploitation. Dynamic phenomena in mines. Technical measures for protection against surface exploitation. Aero pollution from surface mining. Hazards and fire protection measures. Explosions in the mines. The rescue service in the mines.	Ability for identifying and assessing hazards. Ability to record and analyze injuries and occupational diseases. Training for measuring and concentration of gases and planning of protection measures. Capability to measure the concentration of mineral dust and protection measures. Training for the use of respiratory protective devices. Knowledge of the pricipation of technical protection in technological systems of	Combined ex-chatedra lectures with multimedia presentation and interactive teaching with IT support.	https://drive.google.com/file/d/0B_Hn-Zw3UTaubnhENWJCem8xeDQ/view	10.12.2018

			exploitation, preparation and processing of mineral raw materials.			
University of Pristina Kosovska Mitrovica **Faculty of Technical Sciences** **Mining engineering**	Principles of Ecological Engineering	Through this course, students will be introduced to the basic concepts and principles of ecology, with the concepts of environmental protection and ecological factors, their classification, then geoetics, forms of pollution and environmental protection in general. Basic principles of ecological engineering, business design. Planet Earth - global environmental problems. Pollution and protection of soil, creation, characteristics, manner and types of pollution. Pollution and water protection. Natural pollution, pollution of surface, groundwater, industrial waters. Pollution and air protection. Air pollutants with production activities, combustion of fossil fuels, sources and classification. Radioactive contamination and protection. Noise and Noise Protection. Monitoring, models of transport of pollution. Municipal solid waste management: collecting, sorting recycling. Hazardous medical waste. Utility solid waste depot. Industrial waste management Legal regulations in the field of environmental protection. National regulations. EU Directive. Education in the field of environmental protection. Local environmental action plans. The role of NGOs.	Students who successfully pass the exam will have an ecological way of thinking, which will thus become the basis for later behavior and attitudes towards the environment and nature as a whole. The student will be able to critically reflect on existing problems in the context of an engineering approach to nature conservation from the aspect of environmental protection.	Lectures, video beam, DVD, exercises	https://drive.google.com/file/d/0B_Hn-Zw3UTaubnhENWJCem8xeDQ/view	10.12.2018

University of Novi Pazar **Department of Technical Sciences** **Audio and video technologies**	Electroacoustics	The notion of sound. Creation of sounds. Sound propagation. Spherical and plane waves. Velocity of propagation and particle velocity. Sound pressure. Sound intensity in a free field. Sound power. Simple and complex sound. Accumulation of sound intensity in a free field. Accumulation of sound pressure. The definition of decibel. Adding decibels. Decibel calculation (intensity and pressure). Attenuation of a sound pressure level depending on the distance. The role of the attenuation coefficient. Diffraction and refraction of sound waves. The absorption and reflection coefficient. Spatial acoustics. Room absorption. Reverberation time. Absorbing materials and structures. Artificial reverberation. Room acoustics. Mechanical and acoustic resonators. Porous materials. Physiological acoustics. Basic parameters. Pitch, intensity and quality of a sound. Melody, rhythm and dynamics. The hearing part of the ear. Isophon curves. Phones, sones. Voice characteristics. Vowels and consonants. Speech comprehensibility. Formants. Comprehension criteria. Factors influencing comprehensibility. Noise and its acoustic properties. A, B, C features of photometers. Electroacoustic transducers. Microphones. Properties of a speaker. Structure and characteristics of an electrodynamic loudspeaker. Headphones. Acoustic field in a room. Determining sound pressure in different parts of a room. The threshold of audibility. Determining isophon curves	Students should master the basics of acoustics and electroacoustic transducers. Students would be better able to solve independently basic problems in the field of physics, spatial and physiological acoustics and acquire required background knowledge.	Lectures, Laboratory work, Seminar.	http://www.np.ac.rs/ http://www.np.ac.rs/downloads/knjige_predmeta/eng/avt_coursebook.pdf	27.11.2018.

		using headphones. Determining isophon curves using a speaker. Measuring the reverberation time – by means of Sabine equation. Measuring the reverberation time – by means of Eyring formula. Binaural-beat perception.				

APPENDIX II

SURVEY OF THE EDUCATION OF SELECTED UNDERGRADUATE ENGINEERING PROGRAMMES IN SERBIA AT PRIVATE UNIVERSITIES: COURSES RELATED TO THE NO&VIB FIELDS

University **Faculty** **Study program**	**Course**	**Course content**	**Educational outcomes/ Purpose**	**Teaching methods**	**Reference**	**Date**
University 'Union-Nikola Tesla' Belgrade **Faculty of Civil Engineering** **Department of General Construction**	Contemporary Design Methods	Continuous systems. Free, unbroken oscillations of the beam. Determination of own frequencies and their own beam shapes. Orthogonality and its forms. Modular weight of the beam. The forced, damped oscillations of the beam. Bending thin sheets. Free, unbroken oscillations of the panel. Determining your own frequencies and your own shapes. Modular weight of plate. The forced and damped oscillations of rectangular panels which are freely supported on all four angles. Design of constructions according to vibrations. Vibration source (groundborne vibration, vibrating machinery, human-induced excitation). The vibration transmission path (construction object). Vibrator	Acquiring knowledge about oscillations of continuous systems. Training of students for independent implementation of the calculation and verification of the usability of construction structures according to vibrations. Knowledge and ability to apply different legal regulations.	Lectures, Practice/ Practical classes, Consultation, study	https://www.fpb.edu.rs/gradjevina	21. 12.2018.

		receiver (man, machine, process, etc.). Vibrations of pedestrian bridges. Analytical models of a dynamic force bridge that originates from the people movement. Existing regulations (BS5400, BD37 / 01). Synchronous Lateral excitation. Vibration of intercity constructions. Analytical models of the board loaded with the force of walking. Presentation and application of regulations (CSTR43 Appendix G). An example of a calculation for the response of a real interconnected structure according to current regulations. Vibrations of the stadium. Presentation and application of regulations (IStructE / DTLR / DCMS). Restriction of own frequencies. An example of a calculation and analysis of the stadium construction response. Practical exams: Solving tasks and examples from practice.				

APPENDIX III

SURVEY OF THREE SELECTED UNDERGRADUATE PROGRAMMES IN SOUND AND VIBRATION IN EU

University **Study program**	**Course**	**Course content**	**Educational outcomes/ Purpose**	**Teaching methods**	**Reference**	**Date**
University of Southampton **Acoustical Engineering**	Acoustics	Sound Perception: 1. Introduction to Acoustics and Sound Perception 2. The human auditory system and the functioning of the component parts 3. Acoustic metrics and their uses for quantifying sound objectively and subjectively Physical Acoustics: 1. Introduction to Waves 2. Sound Waves in Fluids 3. Acoustic Plane Waves 4. Sound propagation, reflection, transmission, refraction and absorption Special Features: Computational approach to physical acoustics: students understand sound waves by writing programmes to animate them.	Ability to: - Identify the parts of the outer, middle and inner ear explaining their role - Describe what governs or affects the hearing of an individual. - Explain the role of the two ears in distinguishing the direction of an acoustic source. Convert noise levels into dB and linear levels, combining noise sources either coherent or incoherent. - Be able to convert narrowband data into third and octave band levels either with linear or A weighting. - Describe the physical principles for simple transducers and explain what governs their frequency response and which type is appropriate for different acoustic applications. - Explain the meaning of common terms in wave mechanics, such as wavelength, wavenumber, wave speed, diffraction, reflection, dispersion etc. and give examples of how they apply to sound - Relate the speed of sound in a fluid to its physical properties. - Derive the one-dimensional wave equation for both a stretched string and a fluid-filled pipe and explain the assumptions necessary to do so. -Demonstrate (by means of a	Lectures; tutorials; acoustic laboratory demonstrations; exercises	https://www.southampton.ac.uk/courses/modules/isvr1032.page#aims_and_objectives	10.01.2019.

			computer programme where appropriate): standing waves, interference fields, and other wave phenomena. Transferable and Generic Skills: Having successfully completed this module you will be able to: - Information handling - Written communication - Numeracy and manipulating data - Being an independent learner Subject Specific Practical Skills: Having successfully completed this module you will be able to: -Carry out calculations relating to acoustic predictions. - Use a sound level meter and be able to measure sound pressure levels which are calibrated and repeatable, with awareness of the uncertainty and factors that might affect the measurements - Undertake simple acoustic measurements on one dimensional acoustic phenomena. - Collate experimental data. - Manipulate experimental data in order to draw specific conclusions. -Set up simple acoustical problems in numerical software and interpret the solutions. - Write computer programs to visualise and interrogate analytic solutions to acoustical problems			
University of Southampton **Acoustical Engineering**	Mechanics, Structures and Materials	Statics-1 (S1) Fundamental Concepts: Concepts, Units, Scalar & Vector, Revision of statics (adding/resolving forces, moments), types of load/support; Equilibrium of rigid bodies. Free body diagrams. Static determinacy; Trusses: static determinacy, method of joints and method of sections; Stress, strain, elastic constants, Hooke's law;	Having successfully completed this module, one will be able to demonstrate knowledge and understanding of: Statics 1: - The distinction between internal and external forces and the difference between statically determinate structures, statically indeterminate ones, and mechanisms. - The conditions of equilibrium of particles and rigid bodies, and how to	Lectures, group tutorials and laboratory sessions.	https://www.southampton.ac.uk/courses/modules/feeg1002.page#aims_and_objectives	10.01.2019.

		Beams: shear force and bending moment diagrams, differential relationships; Engineer's Bending Theory. First and second moments of area; Beam deflection due to bending, moment-curvature relationship; Differential equation of the deflection curve. Solution by integration; Shear stress in beams. Shear formula. Shear stress distribution in practical sections; Torsion of circular section shafts, polar second moment of area; Buckling of elastic struts. Concept of instability. Euler formula, effective length. Statics-2 (S2); Stress, strain, elastic constants, thermal strain, Hooke's law (2D/3D); Stresses in thin-walled cylinders subject to internal pressure; Two-dimensional analysis of stress. ; Stress transformation using Mohr circles.; Principle stresses and strains Dynamics-1 (D1); Particle Dynamics: rectilinear and curvilinear motion; motion of projectiles; dependent and relative motion; Newton's Laws; free body diagrams; equations of motion.; Work and Energy for particles: principle of work and energy; Energy Conservation; Power and efficiency; Principle of linear/angular impulse and momentum for particles; Equations of motion for systems with variable mass; Rigid bodies Dynamics in 2D: kinematics relationships, centre of mass, mass moment of inertia and equations of motion,; Work and	use them to calculate the reactions at the supports of statically-determinate structures. - How to calculate, and plot diagrams of, the internal forces and moments of statically-determinate beams. - Engineer's Bending Theory and how to use it to determine beam deflection due to bending. - How to calculate bending-induced shear stresses and their distribution in a beam. - The behaviour of a structural member in torsion and how to calculate the stress in a circular section in torsion. - How to solve statically-determinate plane trusses. - How elastic struts buckle and how to calculate the critical buckling load. Statics 2: - Stress and strain in 2D/3D. Free edge conditions. - The way that stress and strain transform in 2D. - The concept of principle stresses and strains. Dynamics 1: Having successfully completed Stream 1, you will additionally be able to demonstrate knowledge and understanding of: - The kinematics and kinetics of particles. - The plane kinematics and kinetics of rigid bodies. - The work done by forces. - The Kinetic/Potential energy and impulse/momentum for particles and rigid bodies in 2D. - The conservation of energy and momentum for particles and rigid bodies in 2D. - The motion of systems with variable mass. - The fundamental concepts of rigid body dynamics in 3D. Dynamics 2: Having successfully completed Stream-2, you will additionally be able to demonstrate knowledge and understanding of: -			

		energy principle for rigid bodies; Principle of linear/angular impulse and momentum for rigid bodies; Introduction to rigid bodies motion in 3D Dynamics-2 (D2); Particle Dynamics: rectilinear and curvilinear motion; Newton's Laws; free body diagrams; equations of motion; Work and Energy for particles: principle of work and energy; Energy Conservation. ; Principle of linear impulse and momentum for particles; Rigid bodies Dynamics in 2D: kinematics relationships, centre of mass, mass moment of inertia and equations of motion,; Work and energy principle for rigid bodies; The fundamental assumptions of lumped parameter mechanical systems, and concepts of equivalent mass, stiffness and damping; Free vibration analysis of a single degree of freedom mechanical system with examples from civil and mechanical engineering; Steady state forced vibration analysis of a single degree of freedom system; Definition of the Frequency Response Function (FRF); Mass, stiffness and damping controlled behaviour; Introduction to multiple degree of freedom systems, the derivation of the equations of motion and a matrix representation of them. Subsequent free vibration solution in terms of modes and the corresponding natural frequencies	The fundamental concepts of kinematics and kinetics of particles. - The fundamental concepts of plane kinematics and kinetics of rigid bodies. - The Kinetic/Potential energy (for particles and rigid bodies in 2D) and impulse/momentum (for particles). - The conservation of energy (for particles and rigid bodies in 2D) and conservation of momentum (for particles). - The fundamental assumptions of lumped parameter mass, stiffness and damper models. - Free vibrations of 1 and 2 degree of freedom systems. - The use of frequency response functions to represent the steady-state vibration of a single degree-of-freedom system. - How the free vibration of multiple degree-of-freedom systems can be derived and solved using a matrix representation. Materials: - The physical origins of properties of materials and their control. - The ways in which properties of materials govern their selection in engineering applications. Subject Specific Intellectual and Research Skills: Having successfully completed this module you will be able to: Statics 1: - Determine whether a structure is statically determinate, indeterminate or a mechanism. - Construct free body diagrams and use them to solve mechanics problems. - Calculate the reactions at the supports of statically determinate structures. - Calculate stresses and strains due to bending and torsion. - Solve statically-determinate plane trusses. - Calculate,			

		Materials (M); Materials in Engineering: Metals, ceramics, polymers and composites.; Fundamentals: Atomic structure and interatomic bonding; electrons, atoms and molecules; the Periodic table; bonding and interatomic forces; the structure of crystalline solids; basic structures, unit cells; holes and lattices; imperfections in solids; point, linear, planar and volume defects; diffusion.; Mechanical properties: Stress and strain; elasticity; tensile properties; hardness; strengthening mechanisms; recovery, recrystallization and grain growth.; Microstructures and their control: Phase diagrams; thermal processing; precipitation hardening; Failure of metals: Failure; fracture, brittle and ductile failure; impact and fracture toughness; fatigue; creep.; Non-metallic materials and their properties: Ceramics and glasses; main classes, properties and uses; polymers; basic structures and bonding; polymerisation; cross linking; thermoplastics and thermosets; composites; main classes, properties and uses.; Materials in engineering applications: Case studies.	and plot diagrams of, the internal actions of statically-determinate beams. - Calculate the deflection due to bending at different points of a beam. - Calculate the critical buckling load of elastic struts. - Interpret experimental data to deduce structural or material behaviour. - Assess whether theoretical assumptions are supported by laboratory observations. Statics 2: - Carry out stress and strain transformations in 2D. - Apply Mohr’s circle to solve stress and strain transformation problems and derive principle strains/stresses. - Interpret measurements using strain gauge rosettes. Dynamics 1: Having successfully completed Stream-1, you will additionally be able to: - Develop particle and rigid body trajectory equations. - Write the equations of motion for particles and rigid bodies. - Apply the principle of work and energy to particle and rigid bodies in 2D. - Apply the principle of impulse and momentum to particles and rigid bodies in 2D. Materials: - Demonstrate how defects in atomic structure affect mechanical properties. - Relate the kinetics of a number of apparently different materials processes to the same underlying process (diffusion). - Explain how strengthening mechanisms occur on the microstructural scale and how this is related to the bulk mechanical properties we require in engineering structures. - Apply the use of phase diagrams to explain the development of microstructure and hence how alloys			

			are designed. - Analyse failure problems and apply the correct fracture mechanics approach. - Show how non-metallic bonding leads to very different properties (e.g. ceramics and polymers). Dynamics 2: Having successfully completed Stream-2, you will additionally be able to: - Develop simple particle and rigid body trajectory equations. - Write the equations of motion for particles and rigid bodies. - Apply the principle of work and energy to particles and rigid bodies in 2D. - Apply the principle of linear impulse and momentum to particles. - Determine both free and (harmonically) forced vibrations of a single degree-of-freedom system. - Analyse the free vibration of a two degree-of-freedom system. Transferable and Generic Skills: Having successfully completed this module you will be able to: -Information handling. - Self-management (e.g. time management). - Written communication. - Numeracy. - Being an independent learner. Subject Specific Practical Skills Having successfully completed this module one will be able to: - Carry out calculations relating to structural behaviour and strength of structural members. - Experiment on idealised forms of structure in the laboratory. - Collate experimental data. - Manipulate experimental data in order to draw specific conclusions.			

University of Southampton **Acoustical Engineering**	Audio and Signal Processing	Fundamentals of signal processing with applications 1. Fourier analysis (continuous and discrete), auto-spectra, cross-spectra, spectrograms. 2. Convolution and its digital implementation. Linear systems 3. Basic theory of linear, time invariant systems. 4. Linear system identification: basic theory and applications. Audio systems and perception 5. Channel quality and sound perception 6. Audio specifications. 7. Theory of sound reproduction (stereophony, loudspeaker-room interaction, etc.) 8. Analogue vs digital audio technologies	To demonstrate knowledge of the basics of digital signals and digital signal processing, of Fourier analysis and to apply it the analysis of audio signals and systems - to demonstrate a working knowledge of the concept of convolution, of the convolution theorem, of digital filters, and of some of their applications -to apply the basic signal processing techniques to estimate the impulse response and frequency response function of a linear, time-invariant system and to interpret the results -to describe and explain the basic operating principles of a range of systems for audio data acquisition and reproduction -to understand the metrics and specifications associated with audio channel quality - to demonstrate a knowledge of the operating principles of sound reproduction and of its limitations.	Lectures; tutorial sessions; computer-based laboratories on applications of digital signal processing	https://www.southampton.ac.uk/courses/modules/isvr2041.page#aims_and_objectives	10.01.2019.
University of Southampton **Acoustical Engineering**	Mechanics, Machines & Vibration	1) Kinematics and Dynamics as Part of the Design Process (2 Lectures): Mechanisms & Machines, Four-Bar Linkage Mechanism, Mobility of Mechanisms, Kinematic Chain (closed), Kinematic Pair, Types of Four-Bar Chain, Kinematic Inversion, Grashoff's Theory, Effect of Joints on DOF, Grübler's Formula, Practical Implications. 2) Design of Mechanisms (2 lectures) Design Considerations (Kinematics Viewpoint), Transmission Angle & Efficiency, Even-Return Mechanism, Quick-Return Mechanism, Design of a Quick-Return Crank-Rocker.	Demonstrate knowledge and understanding of rigid body kinematics of linkages, design of four bar mechanisms, the kinematics and kinetics of simple machine elements and devices -Develop relationships between mass, forces and the motion of a mechanism and the consequent vibrational response of a system to such forces. Subject Specific Intellectual and Research Skills: Having successfully completed this module you will be able to: - Provide critical analysis and conclusions. Subject Specific Practical Skills: Having successfully completed this module you will be able to: - Perform mathematical	Lectures; laboratory sessions; assignment	https://www.southampton.ac.uk/courses/modules/feeg2002.page#aims_and_objectives	10.01.2019.

		3) Moment of Inertia (1 lecture) Experimental Methods for Estimating Moment of Inertia: Compound Pendulum &Trifilar Pendulum, Derivation of Natural Frequencies. 4) Kinematic Analysis of Mechanisms (4 lectures) Position and Velocity Diagrams for linkage mechanism, Instantaneous Centres, Acceleration Diagrams for Crank-Slider Chain and Four-Bar Chain Mechanism Including Coriolis Component of Acceleration. 5) Static and Dynamic Balancing & Gyroscopic Effects (2 lectures) Gyroscopic Effects, Static Balance (Single-plane balance), Several out of Balance Masses, Measuring and Correcting Imbalance, Dynamic Balance (2-Plane balance), Graphical Method, - Moment and Force Polygons. 6) Introducing the software Working Model 2D (2 lectures) 7) Vibration of a SDOF System (8 lectures) -Free Vibration, Damping (Viscous and Structural), Logarithmic Decrement, Harmonically Forced Vibration, Response to periodic excitation, Impulse response, Convolution, Shock spectra, Force and motion transmissibility. 8) Vibration of a 2-DOF System (4 lectures) Free Vibration and Normal Modes, Co-ordinate Coupling and Principal Co-ordinates, Forced Vibration, Damping, Vibration absorber,	analysis of displacement, velocity (via instant centres and vector polygons), and acceleration of Mechanisms. - Produce a formal technical report - Perform kinematic synthesis and analysis of linkage mechanisms - Use Working Model 2D software for kinematic design of a linkage mechanism and carry out motion simulation. - Validate theoretical models through laboratory experiments such as measuring moment of inertia of a complex component - Develop and apply the solutions of the equations of motion to problems for free and forced vibration under harmonic excitation - Use a matrix approach for the solution and understanding of the solutions produced - Conduct vibration analysis of uniform continuous systems and understand the solutions for axial vibration of rods and flexural vibration of beams - Apply approximate methods of solution for non-uniform continuous systems - Carry out experimental work and formulate analytical models and solutions for simple systems.			

		Torsional Vibration of Geared systems, Degenerate systems. 9) Vibration of multi-degree of freedom systems (3 lectures) - Free and Forced Response by Modal Analysis, Introduction to Orthogonality and Generalised Coordinates, Modal Damping and Normal Mode Summation. 10) Vibration of Continuous systems (3 lectures) - Longitudinal Vibration of Rods, Modes of Vibration: Natural Frequencies and Mode Shapes. Forced Vibration of Continuous Systems: Modes and Resonance, Flexural Vibration of Beams, Derivation of Equation of Motion and Procedure for Obtaining Free Vibration Solutions. 11) Classical Methods (2 lectures) - Rayleigh's Method for Fundamental Natural Frequency, Applications to Beams with Discrete Masses and Springs Attached, Effect of Rotation and Different Boundary Conditions. Laboratory Work (10%): 1. Moment of Inertia Measurement of a Connecting Rod (Formative) 2. Vibration measurement and control of a multi-storey tower (10%) Design Assignment (Formative) 1. Dimensional Synthesis of a Quick Return Mechanism and its Efficiency in Torque Transmission.				
University of Southampton	Acoustics II	1. Revision of basic principles of 1D sound propagation from Part I. 2. Conservation equations of compressible fluid dynamics for 3D sound fields.	Disciplinary Specific Learning Outcomes: - Discuss the continuity and momentum equations of fluid dynamics and use them to derive the acoustic wave equation in three dimensions. -	Lectures; tutorial; laboratory sessions.	https://www.southampton.ac.uk/courses/modules/isvr2042.page#	10.01.2019.

Acoustical Engineering		3. The Helmholtz equation and the Wave equation in three dimensions. 4. Sound energy, sound power and sound intensity. 5. Sources of sound: monopoles, dipoles, vibrating surfaces. 6. Acoustic modes in ducts, enclosure and other systems. 7. Transmission and reflection of plane waves obliquely incident on a plane boundary. Labs: 1. Impedance tube measurement. 2. Sound power measurement. 3. Vibroacoustics.	Explain the relationship between the wave equation and the Helmholtz equation, verify the equivalence of the two approaches when solving acoustical problems, and choose which one is appropriate in a given situation. - Define and calculate sound energy and sound intensity. - Account, qualitatively, for the mechanisms of energy loss when sound is absorbed and distinguish between locally reacting and non-locally reacting boundaries. - Calculate the sound-field of monopole and dipole sources and source distributions, illustrate them by means of computer programs, and recognise their relationship to practical sources. - Use the Helmholtz equation to obtain the modes of an acoustical space and explain how they can be used to obtain solutions to source radiation problems in that space. - Calculate the transmitted and reflected waves when plane waves are obliquely incident on a plane interface between two fluids. - Explain the basic measurements made when assessing room acoustics and relate them to the acoustical theory previously developed and the description of absorption.		aims_and_objec tives	
University of Southampton **Acoustical Engineering**	Acoustical Engineering Design	Dependent upon the tasks required for the design problems. The module aims to cover a wide number of both acoustic and vibration principles and, where appropriate, include experimental validation/testing/quantification of the problem. It is anticipated that the following will be covered; Noise and Vibration sources and their quantification; Vibration	Having successfully completed this module one will be able to: -Take noise and vibration measurements analyse the data for frequency content and interpret this in terms of the sources and transmission. - Develop appropriate physical models, produce a numerical implementation of such and then use the numerical models to design against specified targets. - Identify and quantify any vibration control features, e.g.	Presentations; projects ; review ; experimental tests	https://www.sou thampton.ac.uk /courses/module s/isvr3059.page# aims_and_objec tives	10.01.2019.

		control methods; Noise Control Methods; Acoustic and vibration designs for practical implementation Special Features To some extent the investigations and objectives are open-ended and credit will be given for 'thinking off the wall', but supporting any ideas or suggestions with applicable engineering design and theory.	isolation and compare against simple lumped parameter models where possible. -Produce a list of suggested design features and noise control improvements and predict what benefit these might produce. -Be able to present your findings to an engineering audience in a clear and well-structured oral and written presentation			
University of Southampton **Acoustical Engineering**	Noise Control Engineering	Noise control requirements: Motivation for noise control, EC directives on machinery noise and outdoor equipment, specification of noise control targets. Units of noise measurement: Overview of decibels for sound pressure, intensity and power levels; combining sound pressures (incoherent and coherent); basic frequency analysis including one-third octave bands; A-weighting and other measures of sound. Characterization of noise sources: Physical nature of noise sources, idealizations; acoustical efficiency; frequency spectrum; parametric dependencies including operational speed; directivity; estimation of source sound power (including engines, fans etc). Summary of sound power measurement methods. Sound propagation outdoors and indoors: Point source and line source; geometric spreading; ground effects; meteorological effects; noise barriers; sound in rooms, reverberant field.	Ability to use common units of noise measurement, characterise noise sources, be familiar with standard methods for the measurement of sound power - use appropriate formulae for sound propagation, radiation from vibrating sources, transmission through partitions, absorption by porous materials, vibration isolation and damping, attenuation by silencers - select appropriate noise control techniques for the solution of practical noise problems and evaluate their performance -apply the noise control techniques considered in an integrated way to a practical design case	lectures; Various practical demonstrations	https://www.southampton.ac.uk/courses/modules/isvr3064.page#aims_and_objectives	10.01.2019.

		Principles of passive noise control: Effect of multiple sources and multiple paths; noise path models; control at source; airborne transmission; structure-borne transmission. Sound radiation from vibrating structures (engineering approach) Definition of radiation ratio; radiation from monopole and dipole sources; radiation from bending waves in plates; corner modes, edge modes, coincidence; means of reducing radiation ratio. Transmission of airborne sound through partitions Transmission loss of a single partition, mathematical derivation for normal incidence; coincidence and the transmission loss for particular angles of incidence and for a diffuse field (qualitative); double partitions (qualitative); measurement methods for sound reduction index; machinery enclosures using Sabine formula. Sound absorbent materials and applications: Surface impedance and its relation to absorption coefficient; qualitative treatment of dissipation mechanisms; practical forms of sound absorber; measurement techniques for absorption. Vibration control: Force and velocity excitation, blocked force and free velocity; vibration isolation - low and high frequency models; damping treatments; effects of damping; structural				

		modification; vibration absorbers and neutralisers. Silencer design: Acoustic impedance; insertion loss; reactive silencers: side branches, expansion chambers; flow-generated noise; lined ducts, splitter attenuators; pressure drop; break-out noise.				
University of Southampton **Acoustical Engineering**	Finite Element Analysis in Solid Mechanics	The general continuous solid mechanics: - Variational principle in mechanics. Principle of minimum total potential energy. Hamilton's Principle. - Lagrange's equations in dynamics of mechanical systems. - A brief review of normal modes and natural frequencies in multi-degree-of-freedom discrete systems. - Constitutive equations: an overview Finite Element Analysis: - Application of the principle of minimum potential energy to approximate solution of elasticity problems Rayleigh-Ritz Method in statics. - Derivation of equations of motion and FE matrices in structural dynamics. - General FE formulation: aspects of derivation of the element matrices, assembly, application of boundary conditions, solution procedures. - Practical aspects of the use of FE codes: pre- and post-processing. The use of commercial codes e.g. ANSYS. - Finite Element Formulation for 1D elastic continuum (rods, shafts, strings): statics and dynamics - FE formulation for trusses in 2D: coordinate transformations - Beam bending	Having successfully completed this module, one will be able to demonstrate knowledge and understanding of: - Variational principles in statics and dynamics of structure - Fundamental concepts and method of FEA - Direct stiffness, Rayleigh-Ritz methods and FEA. - FEA formulation in solid mechanics. - Fundamental isoparametric elements. Subject Specific Intellectual and Research Skills: - Formulate finite element matrices variationally. - Analyse and build FEA model for various engineering problems. - Identify information requirements and sources for design and evaluation. -Synthesise information and ideas for use in the evaluation process. Subject Specific Practical Skills: -Choose commercial FEA software to solve practical problems through workshops and a design assignment.	Lectures Class discussions Practical FEA model presentation ANSYS computer laboratory sessions (ANSYS not available on VPN) Learning activities include Directed reading Assignments Example exercises and writing of laboratory report Independent learning to use	https://www.southampton.ac.uk/courses/modules/feeg3001.page#aims_and_objectives	10.01.2019.

		elements. Statics and dynamics. - Constant Strain Triangle (CST) elements for plane stress and plane strain, axi-symmetric elements. - 2D Quadrilateral elements - Isoparametric FE formulations. - Element selection Special Features A balanced mix of the theoretical and practical aspects of a tool commonly used in engineering design.		FEA software on computers		
University of Southampton **Acoustical Engineering**	Electroacoustics	Description of electrical, mechanical and electroacoustic systems as two-port networks. Coupling. Analogies. Acoustic networks. Reciprocity. Microphone and loudspeaker arrays. Hydrophones. Equivalent models for moving coil loudspeakers, and relationship to practical loudspeakers. Loudspeaker performance in terms of frequency response, directivity, and distortion, and their measurement. The influence of an infinite baffle, closed box and tuned cabinets. Crossover networks. The horn equation, simple solutions and application, loudspeaker specifications. Power output and mutual coupling. Diaphragm dynamics. Microphones: Pressure and pressure gradient principles. Diffraction. Diaphragm dynamics and transduction mechanisms hence complete frequency responses for various microphone types. Methods of calibration. Directivity of first order microphones. Diffuse field	Ability to: - Describe the general two-port description of transducers including their electrical, mechanical and acoustic properties. - Describe the principles of operation of condenser, ceramic, electret and dynamic microphones. - Microphone calibration methods. - Understand and interpret the literature relating to loudspeaker and microphone design and operation. - Recognise and select appropriate techniques for the analysis of electroacoustic problems - Understand product specifications for electroacoustic transducers and interpret manufacturers' catalogues. - Recognise and use electroacoustic analogies. - Predict changes to the electrical behaviour of a transducer by its mechanical environment and vice-versa. - Describe equivalent models for moving coil loudspeakers. - Recognise and use the Thiele-Small parameters - Discuss loudspeaker and microphone performance in terms of frequency response, directivity and distortion - Predict the influence of a baffle, a closed box and a tuned enclosure on the response of a loudspeaker. - Discuss the use of crossover networks in	Lectures; class and a laboratory session	https://www.southampton.ac.uk/courses/modules/isvr6137.page#aims_and_objectives	10.01.2019.

		response. Highly directional microphones. Microphone specifications. Laboratory: Estimation of the Thiele Small parameters of a loudspeaker driver.	loudspeaker systems - Describe the principles of pressure and pressure gradient microphones and be aware of the frequency limits due to equalisation and diffraction.			
University of Southampton **Acoustical Engineering**	Mathematical Methods for Acoustics	Mathematical methods for acoustics (vector calculus, generalised functions, Fourier analysis, Green functions and theory) Revision of fluid dynamics and acoustics Monopoles, dipoles and quadrupoles Inhomogeneous wave and Helmholtz equations The acoustic Green function Integral solutions of the inhomogeneous Helmholtz equation Sound in enclosures - Sound in ducts - A range of examples/applications in physical acoustics	Having successfully completed this module, one will be able to demonstrate knowledge and understanding of: - More advanced concepts associated with modelling sound fields generated by complex source distributions. - Theoretical models to describe the sound field produced by acoustic sources in enclosures or ducts. - Integral solutions of the inhomogeneous Helmholtz equation, using the acoustic Green function. Explain more advanced concepts in theoretical acoustics, such as the link between acoustic sources and acoustics modes of enclosures and ducts. - Appreciate how to formulate solutions to predict sound fields generated by complex source distributions. - Demonstrate how to use more advanced analytical methods in theoretical acoustics. Reading, understanding and interpreting scientific texts and papers. - Critical analysis and evaluation. - Communication of technical material in written reports. Apply advanced mathematical methods for solving partial differential equations. - Solve examples of practical problems in physical acoustics.	lecture/tutorial sessions; a formative assignment	https://www.southampton.ac.uk/courses/modules/isvr3072.page#aims_and_objectives	10.01.2019.

University of Southampton **Acoustical Engineering**	Human Responses to Sound and Vibration	Sound; 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. Vibration; 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.	Ability to demonstrate knowledge and understanding of: - principal responses to noise (i.e., perception, loudness, annoyance, speech interference, noise-induced hearing loss). - Understand the principal 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). Subject Specific Intellectual and Research Skills: Having successfully completed this module you will be able to: - Read, understand, and interpret the literature relating to noise and vibration effects upon people - Understand the principles of measuring, evaluating, and assessing both noise and vibration. -Apply current standards, limits, and regulations for both noise and vibration. - Recognise and select appropriate techniques for the investigation of noise and vibration effects. Transferable and Generic Skills: Having successfully completed this module you will be able to: -Access and understand British, European, and International standards. - Access and understand European Union Directives. - Deal with logarithmic quantities, SI units, and	Lectures on Sound and lectures on Vibration.	https://www.southampton.ac.uk/courses/modules/isvr3061.page#aims_and_objectives	10.01.2019.

			reference values. - Contribute confidently and appropriately to discussions on similar topics. - Discuss noise and vibration issues in a multi-disciplinary environment. - Assess risk based on technical knowledge and legal requirements. Subject Specific Practical Skills: Having successfully completed this module you will be able to: - Measure noise and vibration (both whole-body vibration and hand-transmitted vibration) to which people are exposed. - Evaluate noise and vibration to which people are exposed. - Assess the severity of noise and vibration to which people are exposed. - Recognise means of preventing, or minimising, undesirable effects of noise and vibration on people.			
University of Southampton **Acoustical Engineering**	Vehicle Powertrain, Noise and Vibration	Powertrain excitation: -Review of balancing of rotating and reciprocating machinery -Primary and secondary reciprocating forces and moments in multi-cylinder engines; Balancing methods - Combustion forcing and torque fluctuations; - Engine working loads, Turning-moment diagram and flywheel design, Friction clutch Power Transmission: - Hydrokinetic drives: Fluid coupling and torque conversion, Torque-speed characteristics. - Gears: Design and analysis, Simple, Compound, Epicyclic and differential gears. Automotive applications. - Drive Trains: Design and Analysis, Planetary Gear Trains - Basic design of a manual gearbox	Understand noise transmission in a vehicle and recommend appropriate methods for noise control - Understand how road roughness is quantified and used in simple vehicle models to predict road induced vibration Basic design of a manual gearbox including the calculations of gear ratios, forces and toques -Select powertrain mount properties to achieve required vibration isolation performance -Discuss sources of noise in automotive vehicles and their characteristics -Cite precise definitions of acoustic quantities and apply fundamental acoustic theory to predict them in a vehicle context -Discuss the motivations for controlling noise and vibration in vehicles Appreciate some of the technical constraints and conflicts in designing a refined vehicle	lectures; assignments	https://www.southampton.ac.uk/courses/modules/feeg3002.page#aims_and_objectives	10.01.2019.

		Powertrain and Chassis Vibration: - Rigid body vibration, design criteria for mounts system optimization, viscoelastic and hydro-elastic isolation mounts, source/receiver mobility models, transmission of powertrain vibration. - Vehicle Noise: - Fundamentals of acoustics: physical description and quantification of sound. - Human response and sound quality. - Motivation for noise control: legislation, quantitative analysis of the drive-by test. - Noise sources: engine noise, intake and exhaust noise, tyre noise, wind noise. - Airborne sound transmission: transmission loss through panels, materials for noise control. - Structure-borne sound transmission: vibration isolation, damping. - Experimental methods for noise path separation. - Analysis of engine noise (e.g., engine order): processing of pre-recorded engine noise data. Assignment 1 (Formative) Design of a Manual Gearbox Assignment 2 (Formative) Powertrain vibration related assignment	Ability to: -Calculate the basic loads imposed by gas-based and inertial forces in a multi-cylinder engine - Employ measures to obtain partial or complete compensation for the inertial forces emanating from the crankshaft assembly - Extract relevant information from an engine turning moment diagram in order to design a suitable flywheel - Acquire skills in the design and analysis of gears and gear trains - Become familiar with hydrokinetics powertrains and torque converters - Implement and interpret simple physical models for vibration of a vehicle's powertrain - Create awareness of some of the quality issues related to the design of a luxury vehicle			
University of Southampton **Acoustical Engineering**	Architectural and Building Acoustics	Building acoustics: - Legal framework: building regulations, particular requirements for schools and hospitals. - Sound insulation (laboratory tests, in-situ tests, single number ratings Rw and Dw, typical building constructions). - Absorption and reverberation time (Sabine and Eyring models, air	Ability to: - Understand standard measurement methods that are used in building acoustics. - Apply prediction methods to assess the transmission of noise in buildings and its mitigation. - Apply prediction methods to assess the reverberation of sound in rooms. - Select appropriate building constructions for the solution of	lectures; laboratory and tutorial classes; Visiting lectures from Arup Acoustics staff	https://www.southampton.ac.uk/courses/modules/feeg6011.page#aims_and_objectives	10.01.2019.

		absorption, typical absorption spectra, and requirements for different purposes). - Background noise criteria (NR, PNC, STI); sources of external noise (rain noise, traffic, etc); sources of noise within buildings (heating, ventilation and air-conditioning noise sources; fans; boilers; chillers; packaged units). - Vibration isolation (of noisy equipment, of buildings); ground-borne noise from underground railways. - Laboratory sessions: measurement of sound insulation; measurement of sound absorption. Auditorium acoustics: - Subjective and objective requirements for different rooms (concert halls, theatres, opera houses, multi-purpose halls). - Reverberation (T20, T30, EDT); other indicators (clarity C80, D50, lateral energy fraction, sound strength). - Absorption of seats, audience, other materials, variable absorption. - Scattering and diffusion. - Measurement of impulse responses; determination of room acoustic parameters from the IR. - Sound source characteristics (musical instruments, speech, singing; sound power, directivity). - Prediction methods (image sources, ray tracing, beam/cone tracing, finite differences, modal methods, physical scale modelling). - Public address system design for buildings and auditoria. - Laboratory sessions:	practical noise problems and evaluate their performance - Make basic room acoustic measurements and determine the various indicators used for auditorium acoustics - Use room acoustics software to model simple auditoria			

		measurement of room impulse responses; use of CATT-Acoustic to predict room acoustics. Optional introductory sessions will be provided for students with no background in acoustics. Special Features - Guest lectures by practicing auditorium designers. - Practical activity measuring the acoustic performance of an auditorium.				
University of Southampton **Acoustical Engineering**	Numerical Methods for Acoustics	Review of fluid mechanics, derivation of the multi-dimensional equations for linear acoustics; Simple solutions of the unsteady equations. ; Time-harmonic acoustics. Complex notation and the Helmholtz eqn.; Acoustic boundary conditions on finite and infinite boundaries; Time-harmonic benchmark solutions.; Acoustic Finite Elements for the Helmholtz problem: 1-D elements; Numerical dispersion and dissipation, the pollution effect. Acoustic Finite Elements for the Helmholtz problem: 2-D and 3-D elements. Boundary element methods for Helmholtz problems. Particular issues for unbounded problems. Finite Difference time-domain methods. Numerical methods based on Ray acoustics.	Ability to: - Understand the equations that govern the propagation of sound in a stationary medium. - Formulate boundary conditions for practical acoustic problems - Understand and evaluate some simple benchmark solutions for acoustics -Understand the underpinning theory and practical application to acoustics of:; frequency domain Finite Elements; frequency-domain Boundary Elements; The Finite Difference time domain method; numerical methods based on ray acoustics - Assess the cost, accuracy and practical limitations of the above. - Define the equations which govern different classes of acoustical problems. -Obtain analytic solutions for simple benchmark problems. - Be able to assess the suitability of different numerical methods for a wide range of practical acoustical problems - Be able to further develop and apply the numerical methods presented in the course to new types of analysis in acoustics and other areas. Write simple computer programs and reports. - To apply critical analysis and evaluation skills. - To read, understand and interpret scientific papers. -To	Lectures; exercises; weekly 'tutorial' class; revision lectures; marked coursework	https://www.southampton.ac.uk/courses/modules/isvr6142.page#aims_and_objectives	10.01.2019.

			synthesise information from a range of sources. - To communicate clearly in written reports. Ability to: - Reduce real world acoustical problems to more simple problems amenable to numerical solution - Select an appropriate numerical method for a broad range of problems in acoustics. - Determine the mesh or grid resolution required for different numerical methods - Validate a numerical code against a relevant benchmark problem. Read and understand user documentation for commercial acoustic code			
University of Southampton **Acoustical Engineering**	Applied Audio Signal Processing	Introduction/review of normal and impaired hearing (psychoacoustics), room acoustics and key signal processing techniques Audio effects; Comb and all-pass filters; Audio effects processing (including equalization, artificial reverb, non-linear and time-variant effects); Automatic gain control and feedback cancellation; Audio compression; Speech processing (including speech enhancement, recognition, synthesis); Real-time audio processing Spatial Audio; Binaural audio; Cross-talk canceller and OPSODIS; Wavefield synthesis and Ambiosonics Array Signal Processing; Uniform linear arrays; Delay sum beamformer; Optimal beamforming; Direction of arrival estimation; Signal detection Case studies, such as; Hearing aids and cochlear implants	Ability to: - Identify and apply appropriate signal processing techniques to analyse audio signals to achieve desired outcomes. - Argue the advantages and limitations of different signal processing techniques in a given context. - Select, implement, apply and evaluate signal processing algorithms to create a range of audio effects. - Select, implement, apply and evaluate signal processing algorithms to analyse signals from sensor arrays. - Describe the basic working principles of human speech production and use signal processing techniques to simulate the process. - Select, implement, apply and evaluate signal processing algorithms for spatial audio reproduction. - Describe and critique the use of signal processing techniques in hearing aids. - Describe, select and evaluate digital audio compression techniques.	Formal lectures; Tutorials; Recorded video lectures; Flipped classroom activities; Practical signal processing exercises; Signal processing assignments	https://www.southampton.ac.uk/courses/modules/isvr3071.page#aims_and_objectives	10.01.2019.

University of Southampton **Acoustical Engineering**	Active Control of Sound and Vibration	; Active control of plane waves in ducts.; Strategies for active control including reflection and absorption.; The use of quadratic optimisation in determining the performance of control systems.; The principles of single-channel control systems for tonal and random signals.; The use of the LMS algorithm in active control systems.; Active control of free field sound.; Multichannel control of tones and random disturbances.; Active control of enclosed sound fields.; Active structural acoustic control using integrated actuators and sensors.; Stability, performance and robustness of feedback systems.; Active headsets.; Active vibration isolation systems.; Active control of waves in structures.; Adaptive signal processing and identification.; Control of nonlinear systems.; Modal control.	Ability to: Understand the equations that govern the propagation of sound in a stationary medium active control of sound in ducts. - Develop reacceptance method for feedback control. - Understand nonlinear control strategies and their potential applications. – Understand multivariable feedback control system. - Formulate independent modal space control. - Understand the fundamentals of harmonic control. - Apply active structural acoustic control. - Formulate single channel control systems. - Understand and formulate active control of free field sound field. - Understand and formulate active control of enclosed sound fields. - Understand the principle of single-channel control systems. - Formulate multi-channel feedforward of tones and random disturbances. - Analyse stability in feedback control. - Understand and analyse performance and robustness of feedback systems. - Understand how active headsets work. Transferable and Generic Skills: Having successfully completed this module you will be able to: - Able to write simple computer programs and reports. - Able to Apply critical analysis and evaluation skills. - Able to read, understand and interpret scientific papers. -Able to synthesise information from a range of sources. - Able to communicate clearly in written reports. Subject Specific Practical Skills: Having successfully completed this module you will be able	Series of lectures, Laboratory sessions. Problem based-learning – Simulation in MATLAB using measured data.	https://www.southampton.ac.uk/courses/modules/isvr6139.page#aims_and_objectives	10.01.2019.

			to: -Develop simple control algorithms to control both sound and vibration through simulation. - Select an appropriate control strategy. - Develop simulation models to predict the behaviour of the system under control. - Read and understand user documentation for commercial codes. Cognitive Skills: Having successfully completed this module you will be able to: - Define the equations which govern feedback and feedforward control strategies. - Obtain active control solutions for simple benchmark problems. - Be able to assess the suitability of different control strategies for a wide range of practical applications. - Be able to further develop and apply the control algorithms presented in the course to other areas.			
University of Southampton **Acoustical Engineering**	Advanced Vibration	Introduction; Terminology.; Review of single degree of freedom systems.; Difficulties of applying conventional numerical methods at high frequency.; Alternatives available for high frequencies.; Applicability of the methods covered in the module Continuous Systems; Equations of motion, characteristic equations, free vibration, forced vibration, modal summation.; Shafts.; Timoshenko beam theory and then reduction to Euler-Bernoulli beam theory.; Love-Kirchhoff plate theory.; Difficulties at high frequencies, high frequency approximations.; Mean square response, kinetic energy.; Frequency/space averaging of	- Have an in-depth knowledge of the theoretical framework for both continuous and discrete structural dynamic models; - understand the benefits and limitations of characterising the dynamics of a structure in terms of its vibration modes and wave behaviour; - understand the process and limitations of Finite Element Analysis (FEA) and Statistical Energy Analysis (SEA) for built-up structures; Subject Specific Intellectual and Research Skills: - analyse the free and forced behaviour of simple structures using modal and wave approaches; Transferable and Generic Skills: - Translate mathematical formulations into computer code such as Python or MATLAB;- Question the validity of	PowerPoint based lectures, tutorials, an in-class quiz and a supervised hands-on laboratory. The three assignments facilitate independent study in the areas of analytical, numerical and experimental methods.	https://www.southampton.ac.uk/courses/modules/isvr6133.page	10.01.2019.

		input power and mobility of finite and infinite systems. Discrete Multiple Degree of Freedom (MDOF) systems; Review of 2 DOF & extension to n DOF systems; Free response (eigen problem), orthogonality and scaling of modes; Forced response (direct and modal summation).; Use of finite element analysis to obtain system matrices.; Model reduction techniques (Guyan reduction).; Damping matrices, normal and complex modes, loss factor. Experimental techniques - Vibration testing (instrumentation, shaker & hammer testing).; Experimental modal analysis (quad picking, circle fitting, rational fraction polynomial method). Waves; Free wave propagation in shafts, beams and plates. ; Non-dispersive vs. dispersive waves, cut-off frequencies; Dispersion equation and curves; Phase/group velocity; Characteristic impedances; Wave energy and power; Reflection & transmission coefficients; Wave excitation. Statistical energy analysis - Introduction: power and energy, power balance, coupling power proportionality.; SEA equations, weak and strong coupling.; Energy equations of a simple oscillator, coupled oscillators and multi-modal systems.; Wave transmission and coupling loss factors,	modelling assumptions in the light of experimental data. Subject Specific Practical Skills:- perform a vibration based transfer function measurement using an instrumented hammer and a commercial frequency analyser;- assess the reliability of measured transfer functions;- process/interpret measured transfer functions using an experimental modal analysis technique.			

		structural-acoustic coupling.; SEA modelling.; Problems and pitfalls with SEA.; Experimental SEA Special Features The module includes a practical laboratory to perform a vibration test on a structure using typical state-of-the-art equipment and techniques that are used in industry.				
University of Southampton **Acoustical Engineering**	Aeroacoustics	- Brief review of fluid mechanics: conservation laws, thermodynamics, vortex dynamics. - Propagation of linear waves in moving media: linearized Euler equations, acoustics, vortical and entropy waves, the convected wave equation, basic properties of sound waves in moving media, sound refraction by non-uniform flows. - Acoustic impedance with flow: definition and properties of acoustic impedance, Helmholtz resonator, Ingard and Myers conditions for impedance with flow. - Methods for solving the wave equations: Green's functions, Green's formula, far field approximations, compact sources, and interferences. - Noise radiation by simple sources: types of sources, effect of source motion, convective amplification, the Doppler effect. - Sound radiation by free shear flows: Lighthill's analogy, application to noise from turbulence. - Noise radiation from solid surfaces: general theory of Flows Williams Hawkings and application to wave extrapolation.	Discuss the generation and propagation of sound in fluids - Explain the principle of the Lighthill's acoustic analogy, and how this is related to sound generated by turbulent flows - Explain how scaling laws may be derived and to interpret these. - Explain how mean flow and boundaries can affect sound generation and propagation. - Apply aeroacoustics theory to new problems. - Understanding of some of the current state-of-the-art research in aeroacoustics. Transferable and Generic Skills: - Write computer programs and reports. - Apply critical analysis and evaluation skills. - Ability to read, understand and interpret scientific papers. Synthesise information from a range of sources. Communicate clearly in written reports. Subject Specific Practical Skills - Recognize and define terms specific to aeroacoustics. - Use relevant mathematical methods to solve problems in aeroacoustics. - Synthesise theory from different fields of study (e.g. fluid dynamics, acoustics, mathematical methods). Model some complex noise generation problems. -	Sessions which will be used to present the theory and worked examples; Tutorial classes	https://www.southampton.ac.uk/courses/modules/feeg6004.page	10.01.2019.

		- Rotor noise: description of source mechanisms from aerofoils, - Duct acoustics: sound field in ducts and wave guides, properties of duct modes. - Turbo-machinery noise: fan rotor-alone tones, interaction tones, buzz-saw noise. - Aeolian tones: cavity noise, flow-acoustic feedback loops.	Appreciate the limitations of different modelling techniques, Cognitive Skills - Analyse aeroacoustics problems and select appropriate methods for solution of the problems. - Assess whether the complexity of a problem in aeroacoustics may be reduced, e.g. by the use of scaling laws. - Improved ability to read and interpret scientific textbooks and papers related to aeroacoustics.			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Audio Information Processing Systems	Representing audio: Audio features and representations. Creating audio: Audio synthesis using statistical and physical models. Manipulating audio: Noise reduction, audio effects, and source separations. Extracting information from audio: Estimation, detection, and classification.	Describe the use of audio information processing systems in application areas such as digital media systems, medicine, and creative arts. Describe the use of signal processing, acoustics, and auditory perception in audio information processing systems. Design and implement audio information processing systems for creating, modifying, and extracting information from audio. Manipulate different representations of audio including waveforms and spectra, cepstral and chroma features, source-filter and sinusoidal models, and perceptual audio coding. Synthesize audio such as speech and music based on statistical and physical models. Transform and process audio including noise reduction, time-scale modification, audio effect filtering, and 3D-spatialization. Extract information from audio such as estimating tempo and fundamental frequency as well as detecting and discriminating between different audio sources.	Lectures, exercises, and projects	http://kurser.dtu.dk/course/2018-2019/02452?menulanguage=dk	10.01.2019.

			Separate mixed audio into individual sources using techniques such as independent component analysis.			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Fundamentals of Acoustics and Noise Control	Fundamental acoustic concepts and measuring units. Human hearing and speech. Measurement and evaluation of sound, A-weighting, time constants and equivalent sound pressure level. Octave and one-third octave band analyses of noise. Addition of noise from uncorrelated sound sources. The use of complex notation. Energy density, sound intensity and sound power. Impedance concepts. Plane and spherical sound waves, interference fields. Reflection and transmission of sound. Sound radiation from monopole and dipole sources, sound radiation from a piston in a baffle. Normal modes in a rectangular room. The diffuse sound field, the energy balance equation in a room and the reverberation time. Sound absorbing materials. Natural modes and resonances in simple mechanical and acoustic systems. Structure-borne sound, vibration isolation of machinery. Sound insulation of single and double constructions. Electrodynamic loudspeakers.	describe fundamental acoustic concepts such as the sound pressure, the particle velocity, the speed of sound, the characteristic impedance of the medium describe and interpret plane sound fields, including standing waves describe and interpret the sound field generated by monopoles and dipoles describe the fundamental properties of transducers calculate sound transmission between two fluids explain the effect of a reflecting plane explain how sound is measured, describe the decibel scale, A-weighted levels, and octave and one-third octave bands explain the usefulness of the concept of sound power and describe how this quantity is used describe and interpret resonances and modes in rooms describe and interpret acoustic energy balance considerations in a room describe fundamental properties of our hearing, hearing threshold, masking calculate sound transmission through simple constructions.	Lectures, problem solving and compulsory hand-ins (problem sets and laboratory exercise reports)	http://kurser.dtu.dk/course/2018-2019/31200?menulanguage=en	10.01.2019.
Technical University of Denmark (DTU)	Electroacoustic Transducers and Systems	Analogies between mechanical, acoustical and electrical systems. Transducers: loudspeakers, microphones and accelerometers; theory, construction, directivity, radiation, measurements and	Explain the principles of analogies between electrical, mechanical and acoustic systems Draw equivalent circuits for simple mechanical and acoustic systems	Lectures, problems, simulations, compulsory laboratory exercises and a	http://kurser.dtu.dk/course/2018-2019/31220?menulanguage=en	10.01.2019.

Electrical Engineering – Acoustics Study Line		calibration. Theory of two-channel stereo. Microphone and loudspeaker configurations. The exercises comprise the measurement of microphones and loudspeakers and stereo recording. PS pice modulization is used for the practice problems. The course also contains a project on loudspeaker system design	Apply the analogies when analysing and modelling electro acoustic devices Explain the two basic techniques in stereo recording Predict the frequency response of dynamic- and condenser microphones and explain the influence of each microphone component in this response Predict the frequency response of electro dynamic loudspeakers and explain the influence of each loudspeaker component on the response Explain the effects of closed and vented enclosures on frequency response and impedance of the loudspeaker and to design such enclosures for a given loudspeaker unit Explain what the common problems in crossover filters design are and how to solve them Select a suitable microphone stereo setup in a simple practical recording situation Make a frequency analysis of simple linear circuits in PSpice	loudspeaker project		
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Acoustic Communication	The anatomy and physiology of the ear. Psychophysical principles and psychoacoustic measuring methods. Psychoacoustics (hearing threshold, loudness, masking, etc). Speech and speech intelligibility. Hearing impairment. Principles of hearing aids and hearing aid fitting. Hearing conservation and hearing protectors. Noise annoyance.	Describe the structure of the ear and explain the function of the various components Sketch the hearing threshold in a free field (dB SPL-Frequency) and interpret the course of the curve Describe classical and adaptive psychometric methods, signal detection theory, and explain a psychometric function Define the concept of loudness and loudness level and describe Stevens' power law	Lectures, exercises with reports	http://kurser.dtu.dk/course/2018-2019/31230?menulanguage=en	10.01.2019.

			Explain the concept of masking (simultaneous-, forward-, backward-) and it's relation to the function of the inner ear Explain how speech is produced and describe the physical properties of the speech signal Define the concept of speech intelligibility, explain how different factors influence intelligibility, and discuss methods for measuring and calculation of speech intelligibility (AI, SII, STI) Describe the principles of sound localization and sketch results of localization measurements Discuss different diagnostic techniques, classify different hearing loss types by means of an audiogram, and explain the implication of a hearing loss for the perception of sound Write an exercise report that is understandable for next year's students			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Technical Audiology and Experimental Hearing Science	E.g.: Methods for measurement of linear and non-linear (adaptive) hearing aids. Clinical tests on test subjects, e.g. auditory brain stem response (ABR), cochlear emission (OAE), speech production and speech intelligibility.	Explain and discuss the principles behind auditory evoked potentials Explain and discuss the principles behind otoacoustic emissions Explain and discuss the principles behind measurements of speech production and speech intelligibility Apply the principles of the above measures in practical lab-based exercises Evaluate and interpret the results from the above measures and relate these to normal/impaired hearing function Plan and carry out a small research project in teams, based on current research and diagnostic techniques	Lectures and laboratory work	http://kurser.dtu.dk/course/2018-2019/31232?menulanguage=en	10.01.2019.

			Compare the results of the research project with supplied current literature Summarise and evaluate the results of the research project by producing and presenting a poster Communicate the project results to a non-specialist audience			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Auditory Signal Processing and Perception	Psychophysics and physiology of the auditory system. Models of auditory signal processing and perception. Neurophysiological measuring methods. Relation between neurophysiological measurements and psychoacoustical (behavioural) findings. Neural imaging techniques. Technical and clinical applications. Compensation strategies in modern hearing aids and cochlear implants. There are classroom-based problem-solving sets and seven MATLAB-based exercises that complement some of the lectures in the course.	Describe and apply basic signal analysis concepts (e.g., convolution, correlation, Fourier transform, sampling, quantization, aliasing) categorize different types of hearing impairments and their perceptual consequences, and evaluate potential compensation strategies in modern hearing aids and cochlear implants interpret the concepts of signal detection theory and explain their implications for psychophysical measurement methods analyse the processing of sound in the cochlea (inner ear), predict the features of cochlear transformation using an electrical circuit (PSpice) characterise the auditory system's frequency selective properties, demonstrate the concept of masking, and evaluate models of auditory masking explain the auditory system's properties of temporal processing, calculate the modulation spectrum of a stimulus, and evaluate the concept of modulation-frequency selective processing discuss methods to measure loudness and intensity discrimination; evaluate models of loudness and intensity coding in the auditory system demonstrate and discuss the principles of spatial and binaural hearing; predict	Lectures and exercises	http://kurser.dtu.dk/course/2018-2019/31236?menulanguage=en	10.01.2019.

			binaural perception data using an equalization-cancellation model relate speech intelligibility performance to the properties of stimulus, room acoustics and state of hearing; compare and evaluate different methods for the measurement of speech intelligibility discuss models of signal processing in auditory neurons, evaluate physiologically inspired models of auditory perception explain methods for measuring otoacoustic emissions and acoustically evoked brain potentials; categorize different types of evoked potentials; interpret the role of cochlear processing for the generation of brainstem potentials			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Architectural Acoustics	The reflection and absorption of sound. Panel absorbers, resonance absorbers and porous absorbers. Theoretical and subjective room acoustics. Acoustics in new and old theatres, churches and concert halls. Room acoustic parameters. Designing of rooms for speech and music. The use of scale models and computer models as design tools. Variation of room acoustics by physical changes and by electronic means. The sound insulation of buildings and building elements from external and internal noise, including forced and resonant transmission, and single and double walls. Sound radiation from vibrations in walls. Introduction to	Explain the principles and basic assumptions behind theories used for sound insulation, such as sound radiation and structural waves in plates and statistical energy analysis (SEA). Predict the flanking transmission and sound propagation in buildings with homogeneous single walls. Calculate the air borne and impact sound insulation of common single and double building constructions, including elements such as floor coverings, floating floors, doors and windows. Describe the sound insulation of older buildings and of modern lightweight constructions. Calculate the sound absorption coefficient for common sound absorbers, including porous-, panel- and resonant absorbers. Relate the objective acoustic parameters with the subjective	Lectures, laboratory exercises, excursion and project work. The projects are similar to real consultant projects, and when possible, include cooperation with external partners	http://kurser.dtu.dk/course/2018-2019/31240?menulanguage=en	10.01.2019.

		structure borne sound and statistical energy analysis (SEA). Floating floors and impact sound insulation. Flanking transmission and sound propagation in building constructions. Sound insulation of older buildings and of modern lightweight constructions. Building acoustic test measurements. About one third of the time is used on a building project in which the acoustical conditions are solved by using the knowledge gathered during the course.	impression of the acoustics of a room or building (such as early decay time, clarity, sound reduction index etc.) Predict the influence of room geometry and absorption, reflection, diffraction and diffusion properties of surface on the impulse response and perceived acoustic condition Design the acoustics of rooms for speech and music in cooperation with architects and building engineers. Understand the basic principles regarding introducing loudspeaker systems for amplification and reverberation enhancement in rooms. Describe the principles and basic assumptions of computer prediction programs such as "Odeon" and "Bastian" and operate these. Explain the basic assumptions and principles of and apply measurement methods in architectural acoustics, including sound insulation, reverberation time, speech intelligibility, sound absorption etc.			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Environmental Acoustics	Human hearing in relation to annoyance and risk of hearing damage due to noise exposure. Types of environmental noise sources. Noise exposure metrics. Acoustic regulation of workrooms. Outdoor sound propagation and noise screens. Noise from roads, railways and airports. Noise from industrial plants. Environmental requirements for noise and vibration. Sound insulation of windows and facades. Sound level measurements and noise	Ability to: classify environmental noise sources evaluate potential health effects of noise exposure depending on the nature and level of the sound source analyse traffic, industrial, and workplace noise and quantify their degree of annoyance describe noise limits for different areas describe outdoor sound propagation and explain by which factors it is influenced plan and perform a noise investigation justify the metrics used as noise indicators for the chosen situation	Overview lectures, excursions, and project work	http://kurser.dtu.dk/course/2018-2019/31250?menulanguage=en	10.01.2019.

		analysis. On-site noise investigation.	relate the investigation results to noise regulations, perceived annoyance, and potential health effects evaluate possible means for reduction of the noise communicate the motivation, methods, results, and interpretation of the noise investigation			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Advanced Acoustics	Plane waves and higher-order modes in ducts. The modal theory of room acoustics; statistical room acoustics. Sound power determination. Measurement of sound intensity. Numerical acoustics (finite element and boundary element methods). Radiation of sound from point sources and plane, cylindrical and spherical sources. Scattering of sound. An introduction to near field acoustic holography and beamforming. Spatial sound, ambisonics and sound field reproduction with loudspeaker arrays.	Ability to: Analyse the sound field inside a duct at low frequencies and design silencer systems. Analyse the timbre of wind musical instruments. Examine the sound field inside a duct, derive the Green's function and explain the propagation of sound inside it. Analyse the sound field in a room based on the modal theory. Derive the Green's function in a room and use it to explain the central acoustic processes that occur in a room. Examine the sound field in a room based on statistical wave models, and how these methods are used in practical applications of room acoustics. Analyse and interpret the decay of sound in a room, based on the modal and statistical theories. Examine a sound field based on its active and reactive intensity and evaluate the usefulness and limitations of intensity measurement. Describe the radiation from point sources, and how coherent sources affect each other. Interpret the expression for the sound field radiated by a spherical source. Illustrate the use of spherical harmonic expansions for sound radiation and scattering.	Lectures, problem solving, project work (laboratory exercises, MATLAB simulations and finite element calculations)	http://kurser.dtu.dk/course/2018-2019/31260?menulanguage=en	10.01.2019.

			Analyse the sound field radiated by a planar source, using space domain and wave number domain formulations. Illustrate the fundamentals of microphone array methods (beamforming and acoustic holography). Describe how these methods are used to analyse sound fields.			
Technical University of Denmark (DTU) **Electrical Engineering – Acoustics Study Line**	Structure-Borne Sound	Mechanisms for the generation of vibration and sound in structures. Simple resonators and models for damping mechanisms. Concepts of mobility and mechanical impedance. Vibro-acoustic measurement techniques. Introduction to applied signal analysis (spectral analysis, estimation of transfer functions, etc). The generation of vibration and sound waves in solids and structures (structure borne sound). Longitudinal waves and bending waves in beams and plates. Analytical and statistical methods for calculating structure borne sound and transmission in complex structures. Vibration isolation, attenuation and damping of structure borne sound in equipment and machinery. Sound radiation from vibrating structures (plates, cylinders, cabinets, etc). Active control and damping of vibration and sound radiation. Principles for altering the transmission and radiation properties of structures.	Ability to: explain the fundamental mechanisms and phenomena which generate vibration and sound waves i solid media and structures conduct calculations and analyses of the dynamic properties of simple resonant systems derive equation of motion for simple resonators and explain frequency responses and determination of damping properties, e.g. from Nyquist diagram explain/evaluate wave phenomena for longitudinal waves and bending wave fields in beams and rods and calculate vibrational responses demonstrate the use of mobility methods for calculating response of built-up systems conduct and report on vibro-acoustic measurements, including applied signal analysis (spectral analysis, estimation of transfer functions, structural damping properties, etc.) explain principle of vibration isolation and calculate insertion loss of simple vibration isolated sources explain reasons for losses in structures and principles for added damping and calculate damping of single-layer viscoelastic vibration damping	Lectures, compulsory mini-projects and experimental exercises, problem solving and review of written exercises	http://kurser.dtu.dk/course/2018-2019/31270?menulanguage=en	10.01.2019.

			evaluate reflection and attenuation of structure borne waves in built-up systems explain and calculate wave fields and propagation of bending waves in plates apply Statistical Energy Analysis and MATLAB-based finite element analysis for calculating vibration in systems explain and calculate sound radiation from compact simple sources and from plate-like structures, cabinets and cylinders			
University of Le Mans **Acoustics and Vibration**	Point Mechanics	Details are not available	Set up the basic tools needed to apply them in vibration, solid mechanics, acoustics, etc.	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Elements of Acoustics	Details are not available	- To master the concepts of intensity (amplitude, sound levels, weightings, loudness, sum of sources), height (frequency) and timbre (spectrum) - To understand the mechanisms of spatial tracking - To know the physiology of the ear - To discover notions of audio (compression) and professional acoustics (building, rooms)	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	1D waves	Details are not available	Understand the main concepts of acoustics by making use of a minimum of mathematical developments	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans	Instrumenta-tion for	Details are not available	- Know the principles of electrodynamic and electrostatic transductions	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme	10.01.2019.

Acoustics and Vibration	Acoustics and Vibration		- Know how to select a sensor and an actuator for a given problem - Know how to calculate the voltages and powers involved in the measurement chain - Know the basics of digitization		(In French)	
University of Le Mans **Acoustics and Vibration**	Vibrations of 1D systems	Details are not available	- To know how to pose and to solve a problem of vibration with 1 degree of freedom, free or forced, amortized or not - To know to identify a clean pulsation, a pseudo-pulsation, a pulsation of excitation, resonance - To know to explain what is a transitional regime and a permanent regime - Know how to write the equation of the movement of an oscillator and know how to solve it	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Fundamental Equations of Acoustics	Details are not available	- Know how to obtain the wave equation from the conservation equations - Revisit the notions seen ACOU 2 - Deal with the problems of free and forced oscillations in 1D	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	3D plane wave	Details are not available	- Extend to 3 dimensions the fundamental equations of acoustics - Reinforce and build knowledge of previous modules - To know how to solve plane wave problems in 3D	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Electroacoustics	Details are not available	- Provide the concepts necessary to deal with problems of guided acoustics or acoustic transduction by the formalism of electroacoustics - apply these notions to the study of acoustic transducers	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.

University of Le Mans **Acoustics and Vibration**	N-dimensional Systems	Details are not available	- To know how to write the equations of the movement for a mechanical system with 2 or 3 degrees of freedom - To know how to extract the free answer and the forced answer of a system of oscillators - Knowing how to obtain the characteristics of the natural modes of oscillations, notably the modal matrix - To know how to diagonalize the structural matrices of inertia and stiffness for systems with 2 or 3 dof	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Elements of Sound Radiation	Details are not available	- Reinforce and build knowledge of previous modules: fundamental equations, 1D waves, fluid column, transmission reflection of a plane wave on an interface ... - To apprehend the acoustic radiation, by that of the monopolar and dipolar elementary sources	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Lagrangian Mechanics	Details are not available	- Have the necessary tools to obtain the equations of motion of a rigid solids system by using the Virtual Powers Principle, then by using the Hamilton Variational Principle, for a system of rigid solids. - To know how to identify a rhéonome, scleronome, holonomic, non-holonomic link - To know how to choose the virtual velocity field which is suitable for the resolution of the problem - To know how to use the Lagrange multipliers - To know how to pose an optimization problem in the form of minimization of integral - Knowing how to use the Hamilton Variational Principle	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.

University of Le Mans **Acoustics and Vibration**	Office Acoustics Design	Details are not available	- Apprehending the profession of acoustician in a design office - Hover over some of the themes treated in BE: room acoustics, building acoustics, environmental acoustics	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Introduction to Acoustic Propagation in Isotropic Solids	Details are not available	- Introduce the basic notions of acoustic propagation in isotropic solids: propagation equation, monochromatic planar waves, transmission and reflection phenomena, application to Evaluation and CND - Know what a compression wave and a shear wave are and what condition (s) they can be generated - Know how to formally write boundary conditions at the interface separating two fluid or solid media - Knowing how to determine critical angles for a given interface, using circles of slowness - Know how to make the connection between the fluid / structure coupling and the ultrasonic propagation in a solid medium	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Basics of Acoustics	Details are not available	To acquire the basic knowledge in acoustics and vibrations necessary to be able to follow the professional courses	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Experimental Acoustics	Details are not available	Learn to use the main acoustic measuring instruments	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.

University of Le Mans **Acoustics and Vibration**	Experimental Vibrations	Details are not available	Learn to use the main vibration measuring instruments	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Perception	Details are not available	Basics of psychoacoustics, ear physiology and pathologies	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.
University of Le Mans **Acoustics and Vibration**	Software for Acoustics	Details are not available	Introduction to the main acoustic software used in industry: - Acoubat (building acoustics) - CATT-acoustic (room acoustics) - CadnaA (environmental acoustics)	Details are not available	https://sites.google.com/site/licenceacoustiquelemans/programme (In French)	10.01.2019.