The schedule of the following lectures is as follows:

November 27: Acoustics
December 4: Dynamics
December 11: Dynamics
December 18: Acoustics & Dynamics, review of the test cases for the examination

=== Project

The ACTRAN project is specified in a set of files that can be downloaded from the usual web site https://arnoresearch.com/vibrations-and-acoustics/.

Technical support by the ACTRAN team is available to students by mail (support@fft.be). Mail will be answered on Monday, Wednesday and Thursday from 2PM to 6PM. Mails' subject MUST start with [ULB] or [VUB].

Work can be conducted in groups but presentation and marks will be individual. Remember that, since the workshop is fully detailed and all data is provided, the mark will be based exclusively in your creativity in using ACTRAN as a virtual vibro-acoustics lab (i.e. changing all accessible parameters) and in your ability to comment the results. Just running the analysis and produce results on the nominal case will not be considered adequate.

Students will be asked to present their approach of the project during the oral exam and will be asked specific questions. Presentation can be done:

1. On the student's own laptop.
2. OR using a color printout.
3. OR using the teacher's laptop PROVIDED that the presentation has been sent by mail to jean-louis@migeot.eu at least a week before the oral examination. The presentation will be considered as received if and only if an acknowledgement of receipt has been received from Jean-Louis Migeot.
4. No USB key, on-line access or other last-minute data transfer will be accepted.

=== Weighting of the different exams

The final mark will be made of:

- 20% of the written exam mark (see below)
- 20% of the project presentation during the oral exam
- 30% of the oral exam (acoustics)
- 30% of the oral exam (dynamics)

=== Written exam

The written exam will happen on Wednesday January 15 from 8AM to 10:30AM in S.H.2215. It will be a multiple-choice question (MCQ) exam. It will be automatically corrected.

As far as acoustics is concerned, the MCQs will be based on the following list of topics:

- <u>Definitions:</u> sound, sound pressure, acoustic velocity, speed of sound, acoustic intensity, impedance, admittance, acoustic power, sound pressure level, sound intensity level, sound power level, A-weighted levels, statistical levels, equivalent levels, weighted levels (Lden), transmission loss (dB value of the ratio of intensity or power entering and leaving a system), absorption coefficient, reflection coefficient.
- Students should have a clear understanding of the difference between damping, attenuation, absorption and insulation.
- Fourier analysis: a periodic signal yields a discrete spectrum whose frequencies are multiple of a fundamental frequency equal to one over the period, a non-periodic signal has a continuous frequency spectrum, definition of the convolution product and understanding of its application to windowing and filtering.
- Students should be able to estimate the fundamental frequency of the sound emitted by simple devices or situations (much simpler than the fan noise problem seen during the exercise session).
- Students should juggle with formulas relating frequency, pulsation, period, wave number, wave length, speed of sound.
- Reverberation time: students should be able to explain the concept of reverberation time, they should know the Sabine formula by heart and should be able to apply it to simple room configurations.
- Acoustic resonances of a tube of length l excited on the left side by a vibrating piston and closed by a rigid termination on the right side happen at frequencies given by the formula: $f=(nc)/(2l)$.

For vibrations, the MCQs will be based on the following list of topics:

- The type and nature of excitation forces in vibrations
- What is harmonic motion, what is the meaning of complex amplitudes
- The mechanism of vibrations, what is resonance and what do the resonant frequencies depend on?
- The response of a single degree of freedom system with and without damping, both in the time domain and in the frequency domain, and the effect of damping. How do you read a Bode diagram? What is the physical meaning of an impulse response and what is its use in vibrations?
- What is the Fourier transform and the difference between the discrete and continuous Fourier transform? What is it used for in applications related to vibrations?
- Fourier transform of sampled signals: what is the effect of the different parameters (length of signal, time sampling), what is aliasing, what are windowing functions, and which should be used for which type of signals.
- What are mode shapes and what is the advantage of projection of the equations of motion on the modal basis. Why is the orthogonality of mode shapes important?
- What are the Rayleigh and the modal damping models? How are they related? What is hysteretic damping?
- What is modal truncation and how to decide on the number of modes to consider for a given application?
- What is low and high tuning?
- What are the main principles to reduce a model to a 1dof system with equivalent mass and stiffness?
- Order of magnitude of damping coefficients in civil engineering structures

- Working principle of a TMD (principles of design)
- Working principle of a direct/inverse isolation device (principles of design)
- Working principle of an accelerometer and a geophone.

Students will be informed of their results as quickly as possible. We will give a more precise date in December after a meeting with the MCQ team. We will also then tell you whether the exam involves negative points or not.

=== Oral exam

The oral examination will be based on a set of predefined practical examples. When the student enters the exam room, he gets one of the practical examples and has 30' to prepare. He then presents his ideas to both teachers simultaneously and answers questions from both teachers. He then presents his ACTRAN project, also to both teachers. Each teacher then gives an independent note to the student for both the exam and the project. The total exam time is maximum 20'.

We expect the student to reflect about the real-life problem, to give a clear, correct and concise description of the problem and of possible technical solutions, relating the problem to relevant parts of the course. We do not expect any theoretical development but do not bar the student from making some if he deems it useful.

The list of test cases will be finalized next week. Their description will be available on the usual web site. You will be notified of these changes.

=== Oral exam dates and schedule

Students may register now for one of the following exam sessions:

- Thursday January 23d: first student arrives at 7:30AM to receive his question, first exam starts at 8:00, last exam ends at 13:00 PM (15 students)
- Thursday January 23d: first student arrives at 13:00PM to receive his question, first exam starts at 13:30, last exam ends at 18:30 PM (15 students)
- Friday January 24th: first student arrives at 7:30AM to receive his question, first exam starts at 8:00, last exam ends at 13:00 PM (15 students)
- Friday January 24th: first student arrives at 13:00PM to receive his question, first exam starts at 13:30, last exam ends at 18:30 PM (15 students)
- Saturday January 25th: first student arrives at 7:30AM to receive his question, first exam starts at 8:00, last exam ends at 13:00 PM (15 students)
- Saturday January 25th: first student arrives at 13:00PM to receive his question, first exam starts at 13:30, last exam ends at 18:30 PM (15 students)

Students will be registered in each group and will pass their exam in order of arrival of their request sent to jean-louis@migeot.eu. We will not give an exact time to each student. Since some students may elect not to pass the exam or may have failed in their written exam, we will call the students one by one as soon as we have finished with the previous student. If a student is not available when we call him, we will call the next student and he will be moved to the bottom of the list. When the last student present has been called, we close the session and any student that was on the list but did not show up by then will be considered absent. DO NOT BE LATE !