Acoustics and Vibrations

1. **Course number and name:** 020AEVES4 Acoustics and Vibrations

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Ali AL Shaer

4. **Instructional Materials:** PowerPoint slides

   Textbooks/References:
   - Vibration, Acoustics and Strain Measurement; Theory and Experiments, C. Sujatha, Springer. ISBN 978-3-031-03967-6.
   - Acoustics – A textbook for Engineers and Physicists, volume I: Fundamentals, Jerry H. Ginsberg, Springer ISBN 978-3-319-56843-0.
   - Acoustics – A textbook for Engineers and Physicists, volume II: Applications, Jerry H. Ginsberg, Springer. ISBN 978-3-319-56846-1.
   - Engineering Vibrations, D.J. Inman, 4th Edition, Pearson**.** ISBN: 0-13-136311-5.
   - Acoustics for Engineers, Jens Blauert and Ning Xiang, Springer. ISBN978-3-540-76346-8

5. **Specific course information**
   a. **Catalog description:**
      This course covers the fundamental concepts in noise and vibrations, the vibrations of bars, beams, and membranes, passive and active damping strategies, damping materials, control methods; and applications.

   b. **Prerequisite:** Mechanical Vibrations (020VMEES2) or Vibrations (020VIBES2).

   c. **Selected Elective** for ME students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
      A student who successfully fulfills the course requirements will have demonstrated an ability to:
      - Determine the response of a vibrating machine/vehicle/structure.
      - Find the response of a human being in a vibrating or acoustic environment.
      - Find out the natural frequencies, damping ratios and mode shapes associated with various modes of vibration (modal analysis).
      - Choose adequate vibration or acoustics testing for different requirements.
      - Estimate the sound power levels of identical machines/products to compare their performances.
      - Determinate the reverberation time of an enclosure.
      - Study the transmission of acoustic signals.
      - Apply vibration suppression and noise reduction techniques.

b. PI addressed by the course:

PI	1.1	1.2	1.3	6.4
Covered	x	x	x	x
Assessed				

7. Brief list of topics to be covered

- **Vibrations of continuous systems:** Vibration of a string or cable – Modes and natural frequencies – Vibration of rods and bars – Torsional vibration – Bending vibration of a beam (Euler Bernoulli and Timoshenko) - Vibration of membranes and plates – Models of damping – Modal analysis of the forced response. (6 Lectures).
- **Introduction to vibration measurement:** Introduction to vibration transducers – Displacement, velocity, acceleration transducers – Introduction to vibration excitation techniques – Non-intrusive (Non-contact) excitation techniques – Digital signal processing – Introduction to signal analysis. (3 Lectures).
- **Fundamentals of acoustics:** Human perception of sound – Sound wave propagation in 1-Dimension – Sound propagation in 3-dimensional space – Some Important acoustic quantities and relations – Sound transmission from one medium to another with normal incidence – Acoustics of enclosed spaces. (5 Lectures).
- **Spherical waves and point sources:** Spherical coordinates – Radially vibrating sphere-time domain analysis – Radially vibrating sphere-frequency domain analysis – Point sources – Dipoles, quadrupoles, and multipoles – Doppler effect – Closure. (5 Lectures).
- **Vibration suppression and noise reduction:** Acceptable levels of vibration – Vibration isolation – Vibration absorbers – Damping in vibration absorption – Optimization – Viscoelastic damping treatments – Noise reduction as a system problem – Noise reduction at the source – Noise reduction along the propagation paths – Noise reduction at the receiver's end. (6 Lectures).
- **Introduction to acoustics measurement:** Choice of microphones – Types of microphones – Acoustic exciters – Sound level measurement – Acoustic chambers. (3 Lectures).