



Final exam questions

Subject group name: **Fluid Mechanics elective – Advanced Technical Acoustics and Measurement Techniques**

Neptun code: ZVEGEÁTNW10

Credit points: 3

Subject in this subject group:

- **Advanced Technical Acoustics and Measurement Techniques**
(BMEGEÁTNW10)

Program: Mechanical Engineering Modelling, MSc (2N-MW0)

Specialization: Fluid Mechanics

Responsible person:

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You can check the current subject forms at the Educational Portal of the Faculty of Mechanical Engineering.

<https://oktatas.gpk.bme.hu/>

Always check the for updates at edu.gpk.bme.hu before preparing for the exam, especially if the subject group contains at least one subject from your final semester!

Valid from 27 February 2023

Dr. Csaba Horváth

associate professor

- 1) Aeroacoustics versus acoustics, sound versus noise, sound wave, speed of sound, harmonic wave, wavelength, frequency, range of human hearing (frequency, amplitude), turbulence and the noise resulting from turbulence
- 2) Sound pressure, sound power, sound intensity, levels, frequency bands (octave, third octave, mid-band frequency, narrowband), Nyquist-Shannon sampling theorem, metrics for perceived loudness
- 3) The acoustic wave equation, assumptions made/limitations, its derivation
- 4) Plane wave versus spherical waves, harmonic wave, point source, acoustic far field, superposition, monopole, dipole, and quadrupole sources
- 5) Lighthill's analogy, derivation of Lighthill's wave equation, Green's function, free field Green's function
- 6) Curle's theorem, Ffowcs Williams and Hawkings equation, Lighthill's stress tensor, Heaviside step function, Doppler frequency shift, Ffowcs Williams and Hawkings surfaces
- 7) Stochastic process, turbulence, broadband noise, tonal noise, time average versus expected value, URANS versus LES versus DNS in CFD (Computational Fluid Dynamics) and CAA (Computational Aeroacoustics)
- 8) Fourier Transform, Inverse Fourier Transform, spectrum (otherwise known as autospectral density, autospectrum, or power spectrum), double sided spectrum versus single sided spectrum, time delay correlation function, cross spectral density, covariance, coherence, phase spectrum
- 9) Aeroacoustic wind tunnels, closed test section, hard-wall test section, open-jet test section, hybrid anechoic tunnel, closed circuit wind tunnel, open-circuit wind tunnel, wind tunnel background noise and the associated noise sources, reverberation, anechoic chamber, reverberation room
- 10) Using microphones for wind tunnel measurements, shear layer, refraction, corrections to be made when placing microphones in the flow and outside of the flow
- 11) Types of microphones, microphone calibration, microphone fore-bodies, microphone support structures, velocity measurement, turbulence, hot-wire anemometry, optical flow diagnostics (PIV)
- 12) Limitations of measurement data, Nyquist criterion, sampling frequency, lower frequency limit, aliasing, uncertainty analysis, random error, bias, variance
- 13) Continuous Fourier transform, discrete Fourier transform, inverse discrete Fourier transform, broadening, convolution theorem, signal sampling, window functions
- 14) Delay-and-sum beamforming in the time domain, mainlobe, sidelobe (spatial alias), point spread function, phased array calibration
- 15) Delay-and sum beamforming in the frequency domain, signal-to-noise ratio, array design, effect of walls, removal of flow noise, integrating beamforming maps