

## Ultrasonics 2021

### Exercise 4

#### Exercise session 24.2.

1. Your neighbor Erkki, whose taste in music matches yours perfectly, listens solely to a 1kHz sine wave sound from his stereo system. Your apartments share a concrete wall which has a thickness that luckily doesn't cause any losses and thus disturb your listening pleasure. How thick is this wall?  $Z_{\text{air}20^{\circ}\text{C}} = 415\text{Rayl}$ ,  $Z_{\text{concrete}} = 8\text{MRayl}$  ja  $c_{\text{concrete}} = 3100\text{m/s}$ .
2. In medical imaging, the Doppler effect is used to measure the circulation speed of blood. An ultrasonic transducer is used to measure a moving target. The frequency of the transmitter is 200 kHz and the medium is water (tissue).
  - a) What is the received frequency when the target is moving towards the transmitter at 2m/s?
  - b) What kind of sound would be heard if the target would move sinusoidally? The Doppler beat frequency is input to a loudspeaker. A qualitative explanation suffices.
3. You have a phase-controlled 1-dimensional 16 element immersion transducer (phased array). You want to focus the pulse from the whole transducer (all the elements transmitting) to a metal surface immersed in water 1 cm away from the center of the transducer. How do you time the transmitting pulses? The size of one element is 1 mm.  $c_{\text{water}} = 1500\text{m/s}$ . (Hint: Olympus has a tutorial on phased arrays available online.)
4. Explain the significance of the following parameters associated with laser-ultrasonics:  
The
  - a) energy
  - b) length
  - c) diameter
  - d) colour
  - e) energy density  
of a laser pulse.
5. You need to measure a laminate structure consisting of 500  $\mu\text{m}$  layers. What measurement method would you use for quality control? (How would you use it?)
  - a) In a laboratory
  - b) In a production line