Ultrasonics 2025
Exercise 4

Exercise session 12.2.

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? $Z_{air20°C}$ = 415Rayl, $Z_{concrete}$ = 8MRayl and $c_{concrete}$= 3100m/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_{water} = 1500m/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 μm layers. What measurement method would you use for quality control? (How would you use it?)

a) In a laboratory
b) In a production line