Ultrasonics 2025
**Exercise 5**

Exercise session 19.2.

1. What are the V(z)- and V(f)-measurements used in ultrasound microscopy?

2. A rod transducer is used to measure the ambient temperature by sending a short US signal along a steel wire/rod and measuring the time difference between the echoes from two dents in the structure. The dents are approximately 3 m from each other. Estimate the measurement accuracy. Is this a good way to measure temperature? (Group velocity of the longitudinal mode in the wire / rod = 4500 m/s, thermal expansion coefficient of steel $1.1 * 10^{-5}$ 1/K, rise time of the pulse 0,15 µs).
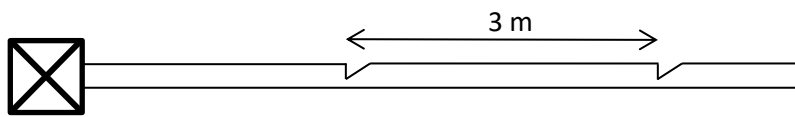
3. What is the B/A-parameter and what does it have to do with non-linear acoustics? Explain two ways to measure B/A for various materials.

4. QCM (Quartz Crystal Microbalance) is a resonator with a narrow bandwidth. A copper cloud of 10 ng is deposited on the resonator in an area with diameter 6.5 mm. The natural frequency of the QCM crystal is 5 MHz.
    a. Calculate the change in the resonance frequency when the copper has been deposited.
    b. The change in frequency is measured by comparing the QCM frequency to a 5MHz reference. How long does it take (from the moment the copper has been deposited) for the phase of the QCM crystal to be exactly opposite to that of the reference?
    c. If the frequency of the reference is stabilized with 0.01 Hz accuracy, what is the smallest detectable change in mass?