Sensing, Computing, Actuating
Lecture 12 - Acoustic Transducers

This instruction exercise consists of three questions that show example questions related to the lecture on acoustic sensors and actuators. In preparation for the exam you should of course not only study these questions, but also the examples shown on the lecture slides.

Exercise 1: Acoustic sensors and actuators

(a) What is the difference between a direct and a complex sensor?

> **Answer:** Direct sensor provides direct conversion from some signal domain to the electrical domain whereas a complex sensor goes through at least one intermediate signal domain.

(b) What is the difference between an active and a passive sensor?

> **Answer:** Active sensor needs current or voltage source. Passive sensor does not need this.

(c) Explain the operation of an electret microphone.

> **Answer:** Capacitive microphone with piezo-electric material that acts as build in charge source (i.e., making it a self-generating/passive sensor). Note that the piezoelectric effect is not used in this sensor.

(d) Can a piezoelectric sensor be used to sense a static force?

> **Answer:** No, when the material is statically dis-formed charges from the environment will quickly neutralize the charge difference due to the dis-formation and no voltage can be observed anymore.

(e) Explain how you can use a piezoelectric material to build a ultrasonic actuator. Add a drawing to your explanation in which you show where the electrical signal should be connected and where the mechanical (sound) signal will be generated.

> **Answer:** Electrodes connected to two opposing sides (e.g., left and right). Mechanical signal generated on two other sides (e.g., top and bottom).

(f) A piezoelectric material can be used to build transducers that transform signals between the mechanical and electrical domain. Pyroelectric materials can be used to bridge two other signal domain. Which signal domains are those?

> **Answer:** Thermal and electrical domain.

(g) A pyroelectric sensor can be connected to a voltage follower or to a current-to-voltage follower. You want to use one of these signal processing circuits in an alarm system to detect a burglar. Which signal processing circuit would you use? (Explain your answer)

> **Answer:** Voltage follower would be suitable as it can detect slow moving objects, but requires less components then a current-to-voltage follower and hence is less expensive.