

Answer all 5 questions. Each question is worth 10 points.

1. Explain shortly (approx. 10-15 sentences each)

- a. Pull-in voltage (2p)
- b. Some microfluidistic way of sorting cells (2p)
- c. How PCR chips work (2p)
- d. At least 4 ways how a micromechanical moving device can lose its energy (2p)
- e. Use and properties of silicon carbide, silicon nitride, silicon dioxide, and polysilicon in microsystems (2p)

2. Micromechanics

Explain in detail with correct equations how you can make a micromechanical device move by using capacitive actuation. Explain the roles of all relevant physical parameters. Additionally, give some approximate values. What kind of forces and amplitudes can you achieve?

3. Noise

- a. What is meant by Johnson-Nyquist noise? When is it playing a major role? What is its spectrum? (5p)
- b. What is flicker noise? What are its sources? Describe some of its properties. (5p)

4. Micro-optical devices

- a. What limits the minimal size of lenses and mirrors when scaling up 2D optical switch architecture? (5p)
- b. What is the main difference in operation principle of imaging systems that are based on DLP systems with Digital Micromirror Devices (DMD) and the ones based on Interferometric Modulator (iMoD) technology? (5p)

5. Design a microsystem that can be used (choose only one!)

- a. to measure the speed of wind
- b. to measure relative humidity
- c. to measure acceleration in two orthogonal directions
- d. to measure angular velocity
- e. to carry medicine inside human veins
- f. as a reference oscillator at 1.8 GHz for mobile phones
- g. as a broad band IR (infrared) source