

S-129.3210 Microsystems Technology (5 cr)

Exam 2.9.2011

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1. Answer following questions.
 - a) Explain what is the pull-in effect in micromechanics, when it occurs, in which cases it is useful and when it may be a limiting effect. (2p)
 - b) Give a detailed reason why in capacitive RF MEMS you need to apply dc voltage in order to operate the component. (2p)
 - c) How can you finetune the relatively high resonance frequency in capacitive RF MEMS resonator? (2p)

2. Discuss in detail both mechanical and electrical properties of silicon in microsystems. (6p)
Some topics:
 - single crystal material versus polycrystalline versus totally amorphous
 - electrical and thermal conductivity, other thermal effects
 - mechanical strength, elasticity properties, possible anisotropy
 - ways to actuate micromechanical parts of silicon
 - silicon oxides and nitrides, SiC, their properties and uses

3. Explain in each case the main application areas of the given materials in micro or nanotechnology and give some physical reason for that. (1p each, 6p total)
 - a) SiC
 - b) Si₃N₄
 - c) SiO₂
 - d) polycrystalline silicon
 - e) diamond
 - f) sapphire

4. Explain the following effects/concepts.
 - a) Seebeck effect (1p)
 - b) Peltier effect (1p)
 - c) Dielectric losses (1p)
 - d) Give at least 3 different ways to measure the temperature using some microsystem. (3p)

5. Answer **either a) or b)**.
 - a) Discuss the role and problematics related to the dissipation (losses in energy) in microsystems. (6p)
 - b) Discuss the technical solutions related to the thermoelectric effect in microsystems, appropriate materials and physical mechanisms. (6p)