# AS-74.3136 Introduction to microsystems

Examination 16.5.2006

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**No books are allowed in the exam! All questions are of equal value.**

**1.** a) Explain what is meant by scaling effect.

b) It is known that the quantity "x" scales as [$S^3$]. When the size of the system is scaled to one half (1/2), the quantity "x" scales as:

1) half of its original value
2) one third of its original value
3) one sixth of its original value
4) one eight of its original value
5) one ninth of its original value
6) one thousandth of its original value

**2.** Consider the device in Figure 1?

a) What is it and what is the measuring principle.
b) What are the advantages and disadvantages of the measuring method.
c) What other types of microsensors (measuring principles) could be used to measure the same variable?

Figure 1

**3.** Describe the basic structure and operation principle of a miniaturized low cost gyroscope (short answer, only the first 60 words will be read).

**4.** **a)** What is meant by microfluidics?

**b)** Explain how the scaling effect appears in microfluidistics.

**5.** **a)** Explain what is continuum assumption.

**b)** What are the advantages of microfluidistic systems compared with macroworld systems.? Mention at least 2 micofluidic applications.

**6.** **a)** What are the most important fabrication methods of silicon?

**b)** What techniques are used in fabrication of deep structures?

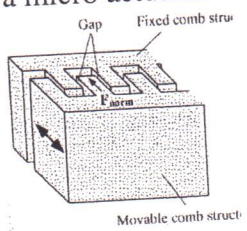
**7.** Microactuators

Explain the following terms (when related to actuators)

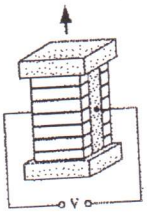
- Resolution
- Accuracy
- Precision
- Sensitivity

**8,** Combine a micro actuator with its design.

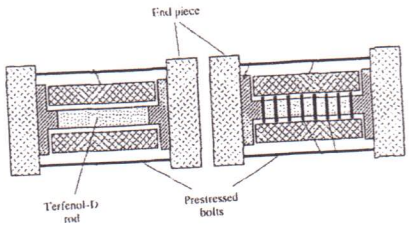

1.




2.




3.




4.

__ __ electrostatic actuator

__ __ magnetorheological actuator

__ __ shape memory actuator

__ __ electrorheological actuator

__ __ magnetostrictive actuator

__ __ piezoelectric actuator

__-__ electromagnetic micromotor

**9.** Are the following statements true or false?

Piezoelectric actuators

| True | False | |
|---|---|---|
| ❑ | ❑ | Piezoelectric actuators provide strains of several per cents which is one of their beneficial properties. |
| ❑ | ❑ | Piezoelectric materials can work either as sensors or as actuators. |
| ❑ | ❑ | Crystal structure of piezoelectric material must be symmetric. |
| ❑ | ❑ | Piezoelectric actuators typically achieve their maximum displacement with voltages less than 12 V. |

(max 1 p., min 0 p.)

Shape memory effect

| True | False | |
|---|---|---|
| ❑ | ❑ | When SMA material is heated, it transforms from an easily deformable state to a rigid state. |

❑ ❑ SMAs are special liquids which change their viscosity when heated.

❑ ❑ SMA materials transform in microseconds from one state to another and they are one of the fastest active materials.

❑ ❑ Strains of only 0.1...0.2 % can be achieved, which is one of the disadvantages of the material as an actuator.

**10**. a) MEMS systems are modeled with lumped parameter models. How are variables classified?

b) Give analogs of variables and components (2 sets is enough)

c) MEMS modeling includes different modeling and simulation techniques. Mention at least two.