

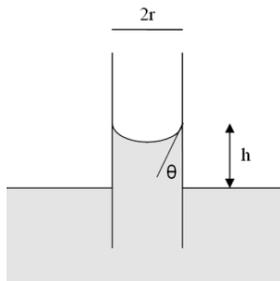
AS-74.3136 Introduction to Microsystems

Examination 07.01.2010

Quan Zhou

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

- What are microsystems?
 - What is the difference between Microsystems and microelectronics?
- What is Lithography? Explain the difference between Lithography and Etching.
- Describe what is the concept of scaling effect?
 - What are adhesion forces?
- What is the working principle of piezoelectric material? Describe different types of Piezoelectric-actuators.
- Draw the diagram of capacitive accelerometer (1 degrees-of-freedom) and explain the working principle.
- What is a micromanipulator? What is a mobile microrobot? Explain how to classify the two types.
- Describe the working principle of an AFM.
- Give three examples of microsystem technology in automotive applications.
- Consider a circular tube which penetrates a surface of water. As a result of *capillarity*, water has a tendency to rise to the tube.



The *contact angle* θ is assumed to be 67.5° .

For water-air surface tension in room temperature, $\gamma \approx 72 \times 10^{-3} \text{ N/m}$.

($\text{Sin}(67.5^\circ) \approx 0.92$, $\text{Cos}(67.5^\circ) \approx 0.38$)

- Derive an equation for the height h by considering force balance.
- With the given values, determine the capillary rise in a tube of radius $r = 0,25\text{mm}$.

10. Consider the plate capacitor in the Figure below: length= L , cross-sectional area= A , gap= d . Apply voltage V across the capacitor. These are all constant.

- Write down the expression for the capacitance C , when the lower plate has moved horizontally distance x .
- Derive the equation for force F , when the lower plate has moved horizontally distance x . Recall that the energy stored in the capacitor is $W = \frac{1}{2} CV^2$
- Derive the scaling laws of a) and b). What is the consequence if the whole device is proportionally reduced 10 times?

