Microsensors (5 cp)
19.03.2018

You may use calculator and MAOL tablebook.
Here is six numbered questions and you may choose five from six available. Answer to five questions ONLY

1. Answer to sub questions
a) Describe a general measurement system? *(3 points)*
b) Explain the difference between wet and dry etching. *(3 points)*

2. a) Describe the sputtering process and draw a schematic of a typical sputtering system. *(3 points)*
b) Explain the principle of acoustic sensing and how acoustic sensors can be used in measuring small masses. *(3 points)*

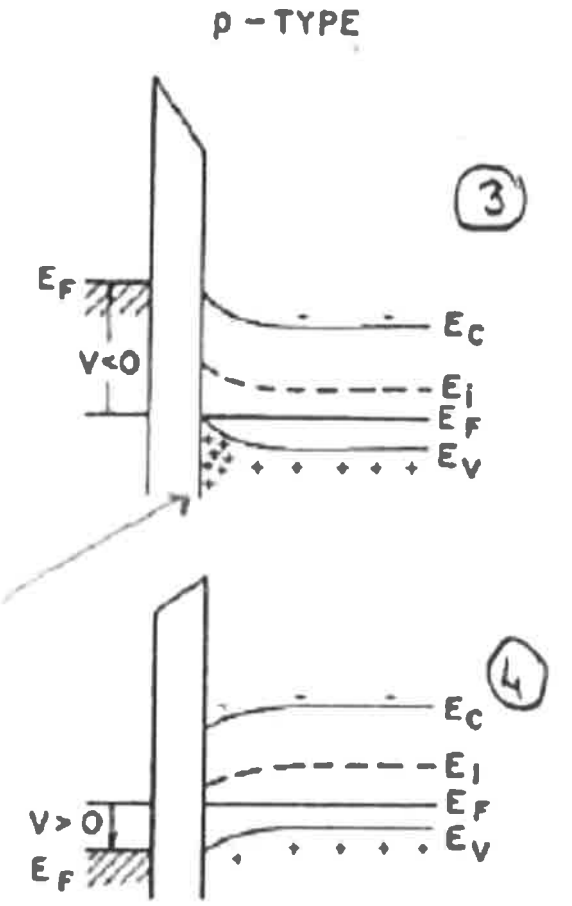
3. a) What is the so called Hall Effect in semiconductors? *(2 points)*
b) Derive an expression for the Hall voltage V_H by starting from the moving charge in the magnetic field. Lorentz force that deflects the charge
is $m^*(\frac{d}{dt}+\frac{1}{\tau})\vec{v} = q(\vec{E}+\vec{v}\times\vec{B})$,
where m* is effective electron mass, τ relaxation time, $\vec{E}$ electric field, $\vec{v}$ velocity and $\vec{B}$ magnetic field. *(4 points)*

4. Answer to the sub questions:
a) Make a list of applications of MEMS sensors and describe the working principle of an acceleration sensor?
b) What are typical selection criteria for car sensors? Mention some critical sensors in autonomous vehicles?
c) Tell about radiation detectors and how charged particles can be detected by a semiconductor detector?

5. a) Describe the working principle of a gas sensor? How does temperature and humidity affect to the sensitivity of a semiconductor gas sensor? *(3 points)*
b) What applications you know for semiconductor gas sensors and what are the used sensing technologies? *(3 points)*

6. Look to the back of the paper for sixth question.

6. We have a MOS structure on p-type Silicon wafer. Electrode metal is aluminium and it is in the left side in following images. V is the applied voltage. Describe the changes in charge densities in semiconductor and in metal depending of the magnitude of V. Remember to mention special cases: charge accumulation, depletion situation and inversion.



a) Tell about the situation in image 3?

b) Tell about the situation in image 4?

c) What you can say about the situation in image 5?