Naturwissenschaftlich-Technische Fakultät
Master Programs Systems Engineering / Quantum Engineering

Name of the module **Microsensors**					Abbrevation
Semester **2**	Reference semester **2**	Term **SS**	Duration **1 Semester**	Weekly hours **3**	Credits **4**

Responsible lecturer	Prof. Dr. Andreas Schütze
Lecturer(s)	Prof. Dr. Andreas Schütze and teaching assistants from the Lab for Measurement Technology
Level of the unit	Master Quantum Engineering, core area Systems Engineering Master Systems Engineering Wahlpflicht im Studiengang Mikrotechnologie und Nanostrukturen (Master, ggfs. bereits im Bachelor zu absolvieren)
Entrance requirements	For graduate students: none
Assessment / Exams	Graded seminar talk, oral final exam
Course type / Weekly hours	3 hours per weeks: Lecture 2 h (weekly) Tutorial 0.5 h (bi-weekly) Seminar presentations 0.5 h
Total workload	Classes, tutorial and seminar talks: 45 h Private studies: 25 h Seminar preparation: 25 h Oral exam preparation: 25 h Total: 120 h
Grading	Final grade is determined from grades of oral exam (70%) and seminar talk (30%)

Aims/Competences to be developed

- Students will familiarize themselves with different microsensor principles including specific advantages and disadvantages as well as fundamental limits for measurement uncertainty etc.;
- Students will gain insights into advanced microsensor system solutions including realization, packaging and technological aspects;
- Students learn to assess advantages and disadvantages of various microsensor principles depending on the application.

Contents

- Chemical microsensors
  - Micro and nanostructured metal oxide gas sensors
    - Fundamental sensor principles: resistance change caused by redox reactions on the sensor surface
    - Micromachined gas sensors
    - Nanotechnology for gas sensors
  - Gas-sensitive Field Effect Transistors (GasFET)
    - Fundamentals: Interaction of adsorbates with semiconductors
    - Classic hydrogen FET
    - Micromachined gate structures (suspended/perforated gate), SiC-FETs
  - IR absorption
    - Fundamentals: interaction of light with molecules
    - Microspectrometer solutions
    - IR gas measurement

        - IR microsensors for liquid analysis
- Magnetic microsensors
    - Fundamentals: magnetic fields and magnetic materials
    - Hall sensors
        - Function principle
        - Realization in CMOS technology including signal processing approaches
        - Approaches for multidimensional measurements (vertical hall sensors, integrated magnetic concentrators, pixel cell)
    - Magnetoresistive sensors:
        - Fundamentals of AMR, GMR and TMR sensors incl. manufacturing process
        - Functional improvement through layout optimization and advanced measurement principles
    - Application examples e.g. from the fields of automation, automotive and consumer applications

- Further microsensor principles, realizations and applications are discussed in the frame of the seminar presentation, current topics are proposed, but students can also suggest their own microsensor according to their interests

Additional information

Language: English

Lecture documents (slides) and exercises are available for download (http://www.lmt.uni-saarland.de)

Literature:
(all books can be can be viewed at the Lab for Measurement Technology after consultation)

- accompanying material (class slides, selected publications and book chapters);
- P. Gründler: Chemische Sensoren – eine Einführung für Naturwissenschaftler und Ingenieure, Springer, 2003.
- T.C. Pearce, S.S. Schiffman, H.T. Nagle, J.W. Gardner (eds.): Handbook of Machine Olfaction - Electronic Nose Technology, WILEY-VCH, 2003.
- U. Dibbern: Magnetoresistive Sensors, in: W. Göpel, J. Hesse, J.N. Zemel (Eds.): SENSORS - a comprehensive Survey; Volume 5: Magnetic Sensors, VCH Verlag, 1989.
- R. Popović, W. Heidenreich: Magnetogalvanic Sensors, ebenda
- S. Tumanski: Thin Film Magnetoresistive Sensors, IoP Series in Sensors, 2001.
- T. Elbel: Mikrosensorik, Vieweg Verlag, 1996.
- R.S. Popovic: Hall effect devices, Adam Hilger, 1991.
- Various journal and conference publications.
- Training material from advanced training courses