

MICRO-602

**Micro-magnetic field sensors and actuators**

Boero Giovanni

Cursus	Sem.	Type
Microsystems and Microelectronics		Opt.

Language of teaching	English
Credits	1
Session	
Exam	Oral
Workload	30h
<b>Hours</b>	<b>14</b>
Lecture	14
<b>Number of positions</b>	<b>20</b>

**Frequency**

Every 2 years

**Remark**

June 11th to 13th, 2024

**Summary**

The course provides the basis to understand the physics, the key performance, and the research and industrial applications of magnetic sensors and actuators. Together with a detailed introduction to magnetism, several magnetic sensors and actuators are studied.

**Content**

## 1. Basics of magnetism

Maxwell laws. Free and bounded currents. Magnetic dipoles. Applications of Biot-Savart, Ampere, and Faraday-Lenz laws. Eddy currents and skin effect.

## 2. Magnetism in matter

Diamagnetism. Paramagnetism. Ferromagnetism. Magnetostatic calculations. Force, torque, magnetic levitation. Galvanomagnetic effects in matter.

## 3. Magnetic field sensors sensors &amp; actuators (principles, key-performance, applications, ....)

Hall sensors. Anisotropic magneto resistance (AMR) and giant magneto resistance (GMR) sensors. Fluxgates sensors. Superconducting quantum interference devices (SQUIDS). Mechanical cantilever-based magnetometers. Magneto-optical sensors. Inductive proximity sensors. RF and magnetic tags, other sensors.

## 4. Magnetic imaging

Magnetic force microscopy (MFM), scanning Hall probe microscopy (SHPM), Magnetic resonance imaging (MRI), other methods.

## 5. Nanomagnetism

Atomic magnetism. From magnetic atoms to magnetic solids. Exchange and anistropy. Superparamagnetism. Magnetic micro and nanoparticles. Magnetic data storage.

**Keywords**

Magnetostatics, Hall effect devices, magnetic resonance, magnetometry, magnetic sensors

## Learning Prerequisites

### Recommended courses

Basic knowledge in physics and mathematics

## Resources

### Moodle Link

- <https://go.epfl.ch/MICRO-602>