

MSE-423

**Fundamentals of solid-state materials**

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Cursus	Sem.	Type
Chemistry and Chemical Engineering		Opt.
Materials Science and Engineering	MA1, MA3	Opt.
Minor in Quantum Science and Engineering	H	Opt.
Quantum Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Lecture	3 weekly
Exercises	1 weekly
<b>Number of positions</b>	

**Summary**

Fundamentals of quantum mechanics as applied to atoms, molecules, and solids. Electronic, optical, and magnetic properties of solids.

**Content**

Fundamentals of electronic structure: the Schrodinger equation and its solution for free electrons, electrons in a potential well, and in a Coulomb potential. Variational principle and diagonalization. Electronic structure of molecules, and approximate solutions with linear combination of atomic orbitals. Hartree-Fock. Symmetry operation and their role in classifying eigenstates. Hamiltonian in a periodic potential and energy bands. Free-electron and tight-binding models. Fermi-Dirac statistics and distribution. Electrical transport and semiconductors. Optical properties of materials, and their quantum origin.

**Learning Prerequisites****Required courses**

Basic knowledge of classical mechanics and electromagnetism.

**Learning Outcomes**

By the end of the course, the student must be able to:

- Elaborate the electronic origin of materials properties

**Assessment methods**

written exam

**Resources****Moodle Link**

- <https://go.epfl.ch/MSE-423>