# Principles of Materials Science

Programme course

6 credits

Materialvetenskapliga principer

TFYA95

Valid from: 2020 Spring semester

**Determined by**
Board of Studies for Electrical
Engineering, Physics and Mathematics

**Date determined**
2019-09-23

## Main field of study
Applied Physics, Physics

## Course level
Second cycle

## Advancement level
A1X

## Course offered for
- Master's Programme in Physics and Nanoscience
- Master's Programme in Materials Science and Nanotechnology
- Mechanical Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering

## Specific information
The course is scheduled for the last time HT2020.

## Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites
Calculus in one and several variables, linear algebra, and mechanics.

# Intended learning outcomes

Materials science is a fusion of multidisciplinary theories and approaches since 1980s, and covers a wide range of scientific and engineering aspects. The primary goal of this course is to provide students a knowledge foundation of the quantum theory, solid-state chemistry, thermodynamics and kinetics, with the relevant mathematical tools and many application examples in materials science, in order to facilitate further studies and understand the inter-relationship among preparation techniques, structures, and properties of various materials, in particular crystalline solids and semiconductors in bulk, thin film, and nano-scale form. After successful examination the student should:

- be able to describe a material, from individual atoms, interatomic bonding, to crystalline periodic structure, with a quantum mechanic perspective
- understand how the structure dictates the properties of various materials at both microscopic and macroscopic levels
- be able to explain mass action and phase transformation processes of solid materials based on both thermodynamic and kinetic considerations
- understand the physics and chemistry behind some commonly used methods for materials synthesis and growth, and how the preparation technique affects the structures and properties of the material
- be able to design a process to prepare (synthesize or grow) the desired material, and calculate the synthesis (growth) rate using kinetic equations of the corresponding chemical reaction.

# Course content

Quantum theory and atomic structures: Wave–particle duality, electron wavefunctions, the Schrödinger equation and basic quantum mechanics, the Bohr atom, the quantum description and electronic configurations of an atom.

Chemical bonding and molecular structures: Properties of bonded atoms, models of chemical bonding and bond hybridization, the Born-Oppenheimer approximation and molecular-orbital theory.

Solid-state chemistry: States of matter and phase transitions, nucleation and assembly of crystals, lattices and structural symmetry, fundamental properties of various matter.

Thermodynamics and kinetics in materials science: Chemical energies and the 1st law of thermodynamics, chemical equilibrium and the 2nd law of thermodynamics, chemical kinetics and reaction mechanisms.

# Teaching and working methods

Lectures, problem solving classes, and laboratory experiments in small groups.

# Examination

| | | | |
|---|---|---|---|
| KTR1 | Problem solving and presentation | 0 credits | U, G |
| LAB1 | Laboratory work | 1 credits | U, G |
| UPG1 | Hand-in assignments | 1 credits | U, G |
| TEN1 | Written examination | 4 credits | U, 3, 4, 5 |

Homework assignment (6 sets) for grade 3 (if more than 70% approved). Optional written examination for higher grades.

# Grades

Four-grade scale, LiU, U, 3, 4, 5

# Other information

### About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is Swedish, the course as a whole or in large parts, is taught in Swedish. Please note that although teaching language is Swedish, parts of the course could be given in English. Examination language is Swedish.
- If teaching language is Swedish/English, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English (depending on teaching language).
- If teaching language is English, the course as a whole is taught in English. Examination language is English.

### Other

The course is conducted in a manner where both men's and women's experience and knowledge are made visible and developed.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

# Department

Institutionen för fysik, kemi och biologi

# Director of Studies or equivalent

Magnus Boman

# Examiner

Wei-Xin Ni

# Education components

Preliminary scheduled hours: 0 h
Recommended self-study hours: 160 h

# Course literature

### Books

Gersten, Joel I., Smith, Frederick W., (2001) *The physics and chemistry of materials* New York : Wiley, 2001
ISBN: 0471057940
Mortimer, Robert G., (2008) *Physical chemistry* 3rd ed. London : Elsevier, 2008.
ISBN: 9780123706171, 0123706173