# Course Specifications

Valid as from the academic year 2015-2016

Quantum Physics for Electronics and Photonics (E024350)

<table>
<thead>
<tr>
<th>Course size</th>
<th>(nominal values; actual values may depend on programme)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credits</td>
<td>6.0</td>
</tr>
<tr>
<td>Study time</td>
<td>180 h</td>
</tr>
<tr>
<td>Contact hrs</td>
<td>60.0 h</td>
</tr>
</tbody>
</table>

## Course offerings and teaching methods in academic year 2018-2019

- **A (semester 2)**
  - Dutch
  - Seminar: coached exercises 30.0 h
  - Lecture 30.0 h

## Lecturers in academic year 2018-2019

- Detavernier, Christophe
  - WE04
  - Lecturer-in-charge
- Callens, Freddy
  - WE04
  - Co-lecturer

## Offered in the following programmes in 2018-2019

<table>
<thead>
<tr>
<th>Programme</th>
<th>Credits</th>
<th>Offering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridging Programme European Master of Science in Photonics</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>European Master of Science in Photonics</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>Master of Science in Photonics Engineering</td>
<td>6</td>
<td>A</td>
</tr>
</tbody>
</table>

## Teaching languages

- Dutch

## Keywords

- Quantum physics, semiconductors, solid state physics, statistical physics, light-matter interaction

## Position of the course

This course aims to provide a broad basic knowledge about quantum physics and semiconductor physics to students in electrical engineering or in photonics. In view of the breadth of the subject the emphasis is on understanding of the concepts and the physical mechanisms rather than on detailed mathematical treatment. At the end of this course the students will be able to understand the quantum physical mechanisms that underly the most frequently used components and techniques in electronics and photonics.

## Contents

- **Quantum physics**: Rationale behind quantum physics, Mathematical methods (Hilbert space, operators, hermitian operators), Postulates of quantum physics, Uncertainty relationship, Schrödinger equation, Illustrations (potential well, tunneling, wave packet)
- **Statistical physics**: Rationale behind statistical physics, Thermodynamics of equilibrium, Ideal gases, Bosons and Fermions, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac distributions
- **Solid state physics**: Cristal structures, Reciprocal lattice, Lattice vibrations and phonons, Band structure (1D Kronig-Penney model, E-k relationships, effective mass), Conductors, isolators, semiconductors
- **Semiconductor physics**: Intrinsic semiconductors and doping, Density of states, Fermi level, Drift and diffusion of free carriers, Recombination processes, The p-n diode, the metal-semiconductor diode, the MOS diode
- **Quantum-electro-dynamics**: Interaction of light with matter: Notions of perturbation theory, Fermi's golden rule; matrix elements and selection rules

## Initial competences

Mathematics and physics from the first and second year Bachelor of engineering.
Final competences

1. Understanding basic quantumphysical concepts (e.g. uncertainty principle, Schrödinger equation).
2. Understanding basic concepts in semiconductor physics (e.g. carrier concentration and mobility, diffusion, recombination).
3. Being able to solve classical one-dimensional problems in quantum mechanics.
4. Applying basic concepts from quantum- and semiconductor physics to explain electronic and photonic components.
5. Being able to draw and interpret energy band diagrams.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment.

Conditions for exam contract

Access to this course unit via an exam contract is unrestricted.

Teaching methods

Lecture, seminar: coached exercises

Learning materials and price

- Several copies of this book can be borrowed from the library in the department of solid-state physics.
- Printed copies of the slides are provided free of charge prior to each class. An electronic version of the slides is made available on Minerva.

References

- Quantum Mechanics, Bransden & Joachain (Prentice Hall).
- Introduction to Solid State Physics, Kittel (John Wiley & Sons).

Course content-related study coaching

Evaluation methods

- end-of-term evaluation

Examination methods in case of periodic evaluation during the first examination period

- Oral examination

Examination methods in case of periodic evaluation during the second examination period

- Oral examination

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

- not applicable

Extra information on the examination methods


Calculation of the examination mark

(Approved)