## Concepts of Spectroscopy 1 (iMOS)

<table>
<thead>
<tr>
<th>Module</th>
<th>Credits</th>
<th>Workload</th>
<th>Term</th>
<th>Frequency</th>
<th>Duration</th>
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<tbody>
<tr>
<td>4</td>
<td>9 CP</td>
<td>270 h</td>
<td>1. Semester</td>
<td>Each WiS</td>
<td>1 Semester</td>
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### Courses
- a) Lectures
- b) Exercises
- c) Integrated laboratory practical

### Contact hours
- a) 2 SWS
- b) 1 SWS
- c) 5 SWS

### Self-Study
- 120 h

### Group size
- a+b) 20 - 50
- c) 5-20 Students

### Prerequisites
- a, b, c) Basic knowledge in quantum chemistry, quantum mechanics, spectroscopic techniques and the necessary mathematical formalism
- c) Admission to M.Sc. iMOS

### Learning outcomes
After successful completion of the module/course, students will be able to:
- Obtain theoretical and practical knowledge of modern linear and nonlinear spectroscopic methods (time- and frequency-domain) which allow for the elucidation of molecular structure and dynamics in different environments
- Understand applications of laser spectroscopic techniques from the THz to the VUV wavelength region to the study of molecules and their interactions
- Understand practical laser spectroscopic techniques in the lab course and their application in ongoing research projects through a hands-on approach
- Write reports with theories, experiments, and discussion of results

### Content
- Electromagnetic radiation, molecular structure, light-matter interaction
- Optical and spectroscopic elements
- Line broadening mechanisms, spectral bandwidth, Fourier transformation
- Molecular symmetry, point groups, molecular symmetry groups
- Rotational spectroscopy: linear, symmetric, spherical, and asymmetric rigid rotor molecules, rotational infrared, millimeter, microwave and Raman spectra
- Vibrational spectroscopy: diatomic and polyatomic molecules, infrared and Raman spectra, vibrational selection rules, normal mode analysis
- Electronic spectroscopy: diatomic and polyatomic molecules, electronic and vibronic selection rules, Franck-Condon transitions, intramolecular nonradiative processes (internal conversion, intersystem crossing), curve crossings and conical intersections
- Laser basics, population inversion and gain mediums, cavity modes, properties of coherent radiation, specific laser systems
- Introduction to nonlinear spectroscopy

### Teaching methods
- a+b) Active participation during lectures and exercises with problems for self-studying, Q&A and discussion sessions with presentations given by the participants, Moodle course with online material
- c) Hands-on laboratory projects to be done in supervised sessions

### Mode of assessment
- a+b) 2-hour end-of-term written exam on the content of the lectures
- c) graded lab reports handed in during the term on the integrated practical

### Requirement for the award of credit points
- a+b) Passing the written examination and
- c) successful acceptance of lab reports
<table>
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<tr>
<th><strong>Module applicability</strong></th>
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<tbody>
<tr>
<td>a+b+c) M.Sc. iMOS; a+b) M.Sc. Chemistry, M.Sc. Lasers and Photonics</td>
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<tr>
<th><strong>Weight of the mark for the final score</strong></th>
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<tr>
<td>Weighted according to CPs</td>
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<tr>
<td>iMOS: CP-weighted average of the exam (5 CP) and the lab report (4 CP) grades according to the examination regulations</td>
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<th><strong>Module coordinator and lecturer(s)</strong></th>
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<tbody>
<tr>
<td>P. Petersen</td>
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<td>Lecturers from Physical Chemistry departments</td>
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| **Further information** |