Course syllabus

Magnetisk resonans - spektroskopi och avbildning
Magnetic Resonance - Spectroscopy and Imaging

KFKN01, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED B/K
Date of Decision: 2023-04-18

General Information

Elective for: B4-mb, K4-m, K4-l, N5-m, MLAK1
Language of instruction: The course will be given in English

Aim

The aim of the course is for the student to learn basic knowledge about Nuclear Magnetic Resonance (NMR) and its applications in the studies of molecular structure and dynamics and in imaging of materials and biological tissue. The course treats methods for studying small molecules, macro molecules and colloidal systems, as well as solid materials.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- understand and explain the basic principles for NMR spectroscopy.
- understand and explain the basic principles for NMR imaging.
- have knowledge about and be able to describe the experimental requirements when NMR is used for spectroscopy, imaging and self-diffusion studies.
- have knowledge on how NMR can be used to study molecular dynamics.
- have knowledge on how multi-dimensional NMR experiments are carried out and on the principles of molecular structure determination.

- have knowledge om how NMR can be used in the studies of solid state materials.

Competences and skills
For a passing grade the student must

- be able to interpret the information obtained with the most common NMR experiments in one and more dimensions.
- be able to describe the dynamical and structural properties of a molecule on the basis of NMR data.
- be able to interpret the results of self-diffusion experiment of colloidal systems.
- be able to perform NMR experiments with only little supervision.
- be able to adequately present results and interpretations of NMR experiments both written and verbally.

Judgement and approach
For a passing grade the student must

- be able to critically assess the outcome of a NMR experiment in terms of accuracy, plausibility and applicability.
- be able to critically review research literature that describes application of NMR.
- have the ability to choose the NMR technique that is most appropriate to apply in a given situation.
- have a broad insight into applications outside his or hers own principal focus of interest.
- be able to actively take part in qualified discussions about applications and interpretations of NMR experiments.

Contents

Lectures: The course begins with basic theory for Nuclear Magnetic Resonance, including an introduction to quantum mechanics. Then follow lectures on chemical shift, nuclear spin interactions, spin dynamics, chemical exchange, relaxation, multi-dimensional applications (including structure determination of macromolecules) and methods for imaging and the study of self-diffusion. The last part of the course is a possibility for each student to make a deeper descent into a subject that he or she finds interesting and relevant. A visit to the MR department at the Lund University Hospital might be offered.

Practicals: An introduction to the data treatment in NMR (including topics like the Fourier transform and artefacts) is followed by practicals covering chemical exchange, relaxation, imaging and self diffusion. An extra practical might be offered as a part of the student’s intensifying task. That practical might cover, for example, structure determination, solid state NMR or molecular dynamics.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: Intensifying task, home assignments, laboratory practicals and Midterm Examination. The final grade is based on a weighted average of the points achieved on the different course components.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0114. **Name:** Midterm Examination.
Credits: 3. **Grading scale:** UG. **Assessment:** Written exam corresponding to 40% (3 points) of the total

number of points awarded for the course. The result of the exam contributes 40% to the total grade point. **Contents:** Exam (midterm) covering those sections of the textbook and handouts that are included in the course. **Further information:** The midterm takes place during a scheduled class meeting.

Code: 0214. **Name:** Intensifying Task: Oral+Written Report.

Credits: 2,5. **Grading scale:** UG. **Assessment:** The test is evaluated based on all of the parts described below. The test result contributes 30% of the final grade. The test corresponds to 30% (2.25 points) of the total number of points awarded for the course. **Contents:** Written report on intensifying task. Oral presentation of intensifying task. Evaluation of fellow students written reports. Opposition on fellow students oral presentations.

Code: 0314. **Name:** Home Assignments.

Credits: 1. **Grading scale:** UG. **Assessment:** The home assignments correspond to 15% (1.125 points) of the total number of points awarded for the course. The result on the home assignments contributes 15% of the final grade. **Contents:** Written reports on home assignments. The course offers 4 weekly home assignments.

Code: 0414. **Name:** Laboratory Practicals.

Credits: 1. **Grading scale:** UG. **Assessment:** A written lab report should be handed in for each practical. These are evaluated and graded by the teachers. The total number of points contribute 15% to the final grade point. The lab practicals and reports correspond to 15% (1.125 points) of the total number of points awarded for the course. **Contents:** Laboratory practicals using computers and/or NMR-spectrometers: 3 practicals using NMR-spectrometer + 1 computer-based practical.

Admission

Assumed prior knowledge: FMAB30, FMAA20, KFKA05 Molecular Driving Forces 1: Thermodynamics. Basic organic chemistry, KFKF01 Molecular Driving Forces 2: Interactions and Dynamics, and KOKA25 Organic Chemistry, Basic Course.
The number of participants is limited to: No
The course overlaps following course/s: KFK095, KEMM17

Reading list

- Keeler, J: Understanding NMR Spectroscopy, second edition. Wiley, 2010, ISBN: 0-470-74608-0. The book is also possible to buy as e-book.
- Instructions for practicals.
- Other literature (mostly scientific articles) are handed out during the course.

Contact and other information

Course coordinator: Mikael Akke, mikael.akke@bpc.lu.se
Course coordinator: Kristofer Modig, kristofer.modig@bpc.lu.se
Course homepage: https://www.cmps.lu.se/education/
Further information: The course is also given as KEMM57 at the faculty of Science and is taught as a collaboration between the divisions of Biophysical Chemistry and Physical Chemistry. The two department share many years of experience with a multitude of different applications of the technique.