Faculty of Science

MAXM26, Experimental Methods and Instrumentation for Synchrotron Radiation Research, 7.5 credits

Experimentella metoder och instrumentering för synkrotronljusforskning, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by The Education Board of Faculty of Science on 2024-12-10. The syllabus comes into effect 2024-12-10 and is valid from the autumn semester 2025.

General information

The course is a compulsory course in the second cycle for a degree of Master of Science in Physics, specialising in Synchrotron Radiation Based Science. It is also offered as a freestanding course.

Language of instruction: English
The course is taught in English

Main field of study	*Specialisation*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

MAX IV is one of the most advanced X-ray sources in the world that provides opportunities for leading research. However, the usage of MAX IV and its application to key research topics can be cumbersome. The overall goal of the course is for the student to acquire knowledge about the characteristics, instrumentation and research opportunities at MAX IV and similar facilities around the world.

Knowledge and understanding

On completion of the course, the student shall be able to:

- Describe the properties of synchrotron radiation (coherence, brilliance) and its sources (bending magnet, undulator, wiggler)
- Account for the properties and name the optical components (mirrors, lenses, gratings, multilayers, zone plates, crystals) for photon energy ranges from infrared to hard x-rays
- Account for the properties of detectors and needs for a given experimental technique
- Describe the design of a beamline for spectroscopy, structure determination, imaging, microscopy, tomography
- Account and name common experimental techniques and methods used at synchrotron radiation facilities for spectroscopy, structure determination, imaging, microscopy, tomography, etc.

Competence and skills

On completion of the course, the student shall be able to:

- Apply and identify synchrotron radiation techniques to solve specific scientific questions
- Discuss and propose potential experiments at synchrotron radiation facilities or X-ray free-electron lasers tailored to a specific question and devise potential outcomes
- Perform a simulation and thereby optimising parameters for undulators, wigglers, and bending magnets based on a requirement specification for the photon energy range, photon flux, polarisation, as well as the performance (electron energy, emittance, beam size) of the storage ring
- Implement simulations and thereby optimising parameters for optical components (including reflective, refractive, and diffractive) in order to optimise the performance with regard to the photon energy range, photon flux, energy resolution, polarisation, focusing
- Report on and communicate basic synchrotron radiation results to the public and to peers.

Judgement and approach

On completion of the course, the student shall be able to:

- Critically review and discuss the suitability of synchrotron radiation for specific scientific cases
- Assess and reflect on the plausibility and significance of the reported result

Course content

The course covers:

- The properties of synchrotron radiation from bending magnets, insertion devices, and how they are linked to the parameters of the storage ring, and the insertion device.
- The instrumentation used at a synchrotron radiation facility.

- Experimental methods based on synchrotron radiation.
- Properties and experimental methods for free-electron lasers.

Course design

Teaching consists of lectures, laboratory exercises, computational exercises, seminars, group exercises, and tutorials at the MAX IV laboratory. Participation in group exercises, demonstrations, tutorials, lab experiments, and associated elements is compulsory. The compulsory parts require active participation during the course.

Assessment

Examination is in the form of written and oral assignments during and at the end of the course, the laboratory report, participation in compulsory parts, and with an oral exam at the end of the course. The oral exam also checks the independence of the written assignments.

Students who do not pass a regular evaluation will be offered another opportunity for assessment soon thereafter.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
For a Pass grade on the whole course, the student must have Pass grades on the oral exam and all compulsary components.

The grading scale for the oral exam is Fail, Pass, Pass with distinction.

The final grade is determined by the grade on the oral exam.

Entry requirements

To be admitted to the course, students must have 90 credits in natural science and/or engineering.

Proficiency in English equivalent to English 6/B.

Further information

The course replaces MAXM16, Experimental Methods And Instrumentation For Synchrotron Radiation Research, 7.5 credits, and credits from that course cannot count towards a degree together with this course.

Knowledge of Python, MATLAB, or similar programming framework is recommended, but is not a requirement.

The course is in full coordinated with EXTM90, Experimental Methods and Instrumentation for Synchrotron Radiation Research, 7.5 credits which is a course given at Lund Institute of Technology, LTH.

The course is offered at the department of Physics, Lund University.