Faculty of Science

MAXM05, Accelerators and Free Electron Lasers, 7.5 credits

Acceleratorer och frielektronlasrar, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2012-06-20 and was last revised on 2012-06-20. The revised syllabus applies from 2012-01-16, spring semester 2012.

General Information

The course is included in the main fields of synchrotron radiation based science and physics at the Faculty of Science. It is also included in the Master of Science programme in Synchrotron Radiation Based Science at the faculty of Science.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Synchotron Radiation Based Science	A1F, Second cycle, has second-cycle course/s as entry requirements
Physics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

The objective is that the students, on completion of the course, shall have acquired the following knowledge and skills.

Knowledge and understanding

On completion of the course, the students shall demonstrate

- knowledge of different accelerator types and how they function
- understanding of and ability to apply basic beam dynamics for accelerators
- understanding of accelerators for synchrotron radiation
- basic understanding of the free electron laser (FEL) process and different types of

- awareness of key accelerator subsystems
- knowledge of the structure, operation and safety of an accelerator laboratory

Competence and skills

On completion of the course, the students shall

- know and be able to apply basic physical methods of relevance to accelerators and FELs
- know and be able to perform simple simulations of accelerators

Course content

The course comprises 7.5 credits and is not divided into different components.

The course focuses on accelerators for synchrotron radiation production (linear accelerators and synchrotrons), their function and structure, and how their properties connect to different areas of application. The different components of an accelerator are analysed (different types of electron guns, linear accelerators, storage rings, problems and solutions). The theory of magnets (dipole, quadrupole and general magnets) and how they are used in beam dynamics are described (particle optics, focusing, matrix formulation, betatron and synchrotron oscillations, beta functions, betatron (frequency and) tune , emittance, etc.). This is used to build simulation models of accelerators. The impact of resonances, magnet errors and certain high-order optical effects are discussed. The acceleration process in cavities and linear accelerators is described.

The free electron laser (FEL) process and different types of FEL (SASE, cavity-FEL, harmonic generation, high-gain harmonic generation, seeding) are described, and the physics about the amplification process is analysed. The course includes repetition of synchrotron radiation and undulators, but with a focus on FEL.

Course design

The teaching consists of lectures, laboratory experiments and demonstrations at MAX IV Laboratory, seminars and group exercises. Participation in group exercises, demonstrations, study visits, lab experiments and associated teaching is compulsory.

Assessment

The assessment is based on written assignments, but can also include a complementary oral assessment.

Students who fail an assessment will be offered another opportunity for assessment soon thereafter.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a grade of Pass on the whole course, the student must have been awarded this grade on the lab reports, written assignments, and participated actively in all compulsory components.

The final grade is determined by an aggregate of the results on all assessed components.

Entry requirements

To be admitted to the course, students must meet the general requirements for admission to Swedish higher education and have 90 credits in science, including the courses MAXM06 Introduction to Synchrotron Radiation Based Science, 7.5 credits, MAXM07 Introduction to Accelerators and Free Electron Lasers, 7.5 credits, and MAXC11 Production of Photons and Neutrons for Science, or the equivalent.

Subcourses in MAXM05, Accelerators and Free Electron Lasers

Applies from V12

1201 Accelerators and Free Electron Lasers, 7,5 hp
Grading scale: Fail, Pass, Pass with distinction