

## Faculty common course 2021

English course title: Electron microscopy

Swedish course title: Elektronmikroskopi

Extent (credits): 5

Language of instruction: Engelska

Recommended prerequisites: Knowledge taught in engineering, materials' science, physics, chemistry, medicine, pharmacy and biology curriculae is sufficient to follow this course.

Learning outcomes of the course: Aims (relaterad till Högskoleförordning, bilaga 2, Kunskap och Förståelse):

- Understand systematically the basics of electron microscopy
- Being able to develop the methodology to solve material analysis problems using down to single atom scale with electron microscopy techniques and foster the competence to relate the result from electron microscopy analysis to the properties of physical, chemical and biological matter.

Learning outcomes (relaterad till Högskoleförordning, bilaga 2, Färdighet och Förmåga):

1) Develop the skill to use nano- and atomic level electron microscopy analysis for impacting the development of novel materials. 2) Understanding of principles of electron/ion-matter interaction in electron microscopes and apply electron microscopy techniques quantitatively. 3) Learn methods at the forefront of electron microscopy as well as focused ion beam techniques. 4) Learn the use of electron microscopy techniques in biology.

Specify which learning outcomes of the doctoral degree that are address/covered (see appendix 1 of the call or the template of ISP). Describe how:

How: The examination goals are reached by a combination of lectures, laboratory courses, group work and assignments. The course contains student centred teaching and in all course elements, the students are actively encouraged to contribute to the course. Forefront electron microscopy methods are presented and related research works are discussed with the course participants fostering knowledge, critical understanding and independent thinking.

The course addresses PhD students from Biology, Geology, Chemistry, Physics and Engineering department and is cross disciplinary. The course is shared between hard matter and biological matter study. The inclusion of topics on electron microscopy on soft matter gives insight for students with a materials' science background in characterisation methods of biological materials. Students from biology and chemistry are welcome to learn the basics of electron microscopy which has a strong presence in both, materials and life science. In 2017, we have launched a novel EM centre (CEM4MAT) between UU, SU, KTH and involve teachers from these sites to the

course. Furthermore, the exchange of students from many different disciplines, both in laboratory and assignment groups fosters cross-disciplinary knowledge.

Course contents: In this course we will teach the methodology that is needed to use electron microscopes and focused ion beams for characterization of materials and to make an active contribution to the development of modern materials. The course contains the following parts: 1) Electron microscopy techniques spanning across several disciplines such as physics, biology, medicine, materials science, their basis and electron-sample interaction. 2) We will illustrate the use of electron microscopy with the corresponding applications in materials science, physics, chemistry and biology. 3) The focused ion beam device is presented with its capacity sputter samples with a nanometer precision as well as to use it for a local TEM sample lift-out. 4) The students will be confronted to selected problems/techniques in the laboratory course sessions in several state of the art Electron Microscopy laboratories in Uppsala. The study format of the course consists of lectures, laboratory course and assignments. To pass the course, the students must hand in the answers to our assignments and approve the assignments. The course will be passed finally, when the student has passed the oral exam.

Instruction (course structure): We build a special tutorial program to improve the student centered learning and group work.

The course is a block course in 2 times one week. Week 1 is dedicated to SEM and FIB teaching and laboratory course, week 2 is dedicated to TEM. Physical and biological science are taught across the two weeks. The theory is in the morning, laboratory course is in the afternoon.

The students will work together in groups both in the laboratory course and the same groups will elaborate together the assignments. To foster knowledge and also to build a creative assignment group environment, the groups will be accompanied by tutors..

Assessment (form of examination): The course will be evaluated by assignments that are related to course (both theory and laboratory course) contents as well as by a final oral exam .

Course examiner (name, e-mail): klaus.leifer@Angstrom.uu.se

Department with main responsibility: Materialvetenskap

Contact person/s (course responsible teacher) (name, e-mail): Klaus Leifer, klaus.leifer@Angstrom.uu.se

Course dates/period: February-Mars 2021

Maximum number of participants: 32

Submit the application for admission to: Klaus Leifer

Submit the application not later than: 30th January 2021