UNIVERSITY OF GOTHENBURG

PHYSICS

FIM640 Nanotechnology for Sustainable Energy, 7.5 higher education credits

Nanotechnology for Sustainable Energy, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Physics on 2008-01-28 and was last revised on 2017-06-13 to be valid from 2017-06-13, spring semester of 2017.

Field of education: Science 100%
Department: Physics

Position in the educational system

The course FIM640, Nanotechnology for sustainable energy, is a single subject course within the Masters Programme of Physics of Materials and Biological Systems and is also given as a stand-alone advanced course in physics at the Department of Physics, University of Gothenburg.

The course can be part of the following programmes: 1) Complex Adaptive Systems, Master's Programme (N2CAS), 2) Physics of Materials and Biological Systems, Master's Programme (N2PMB) and 3) Physics, Master's Programme (N2PHY)

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

Entry requirements

Basic knowledge in physics equivalent to a Bachelor degree and/or in chemistry is recommended.

Applicants must prove knowledge of English: TOEFL test result of at least 600 points (computerized 250 points, on Internet 100 points) or IELTS test result of at least 6.0, including at least 6.5 for the Writing. This requirement does not apply to students with a

Bachelor degree from an English speaking university, or to students having passed English level B at Swedish/Nordic Upper Secondary School.

Learning outcomes

- Give an overview of the opportunities and limitations of what N&N might contribute with to the future energy system. This will require an ability to describe and reflect upon mankind s current and future energy situation.

- Understand and be familiar with the different N&N fabrication and characterization methods, including advantages and shortcomings for specific applications.

- Explain how and when N&N comes into play in the development of new or improved energy and associated environmental solutions.

- Collect, analyze, organize and present, orally and in written form, information related to a task/topic identified in the form of a mini-project.

- Have sufficient knowledge in N&N to assess the presentations of their student colleagues (in the areas covered by the course) and give feedback to them, thereby demonstrating critical thinking skills.

Course content

The aim of this course is to describe and make the students acquainted with the potential and state-of-the-art of Nanotechnology and Nanoscience for sustainable energy and environment systems. As a background, a broader overview of the global energy system will be given in introductory lectures.

On a time scale of 15-40 years, a slow-down in raw oil production is often predicted, with accompanying rising prices. With coal as a buffer , this time scale might be extended significantly, but at the risk of severe CO2 emissions into the environment. On the other hand, there are schemes for CO2 sequestration. In any case, energy, and the associated environmental and climate effects, can be identified as one of the most important future challenges for the global society, implying an urgent need to develop a sustainable energy system. Such a system is likely to be much more diversified than today s system, including solar, biomass, geothermal, wind and wave, and nuclear sources of energy. It will hopefully be characterized by a much more efficient and environmental friendly use of energy in the industrial, public and private sectors. On the

shorter term, while new ways of supplying energy are developed, the efficiency in the use of fossil and renewable sources, can and should be improved in all sectors; industrial production, transportation, buildings and housing.

Nanoscience and nanotechnology (N&N) have the potential to contribute significantly to the goals identified above. This statement applies both to the long-term time scale needed to reach a truly sustainable energy system, and to short-term challenges of improved efficiency in today s energy systems. It also applies to solutions of some of the environmental challenges associated with the energy system.

Potential areas, where N&N will or might contribute to sustainable energy and environmental technology, and which will be covered in the course are:

- Photovoltaic materials (Solar cells)
- Hydrogen production, conversion, storage and use
- Catalysis for cleaning of automotive and industry emissions
- Electrocatalysis, e.g. fuel cells
- Batteries
- Catalysis for reduced energy consumption in industrial processes
- Sensors for improved energy efficiency in industrial processes and housing
- Smart windows and isolation materials for energy-efficient buildings
- Efficient lighting solutions (white LEDs)
- Superstrength nanomaterials
- Thermoelectric structures and materials
- Water cleaning
- Gasification/liquefaction of coal and biomass
- CO2 fixation

The course will give both an overview of these areas and detailed descriptions of many of them with regard to current state-of-the-art in technology, ongoing research worldwide, and also discusses the difficult question when the different technologies might be expected to reach the market. It should be noted that several of the areas in the bullet points above are treated in other courses at Chalmers. Here the perspective is on what N&N can contribute. When required for the different topics, the course will treat related materials science aspects and surface technologies. Nanoparticles and their potential role for weather and climate will be briefly discussed. The so-called nanosafety and nanoethics aspects will also be covered.

Form of teaching
The examination will be in the form of:

1) 3-4 quizzes on the course lectures. All quizzes have to be completed, and the summed-up result of all quizzes must be beyond the threshold for passed (it is thus possible to fail on an individual quiz).

2) A mini-project on a topic selected together with the teachers of the course. The mini-project has to be presented as a written report and as an oral presentation at a one-day course symposium at the end of the course. Written report and oral presentation will be graded with weight 2:1 (written:oral).

Language of instruction: English

Assessment
In order to pass the course, students have to pass each of the two examination moments 1) and 2) independently.

A student who has failed a test twice has the right to change examiner, unless weighty argument can be adduced. The application shall be sent to the board of the department and has to be in writing.

Grades
The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).
ECTS grades are also given on this course.

Course evaluation
The results of the evaluation will be communicated to the students and will function as a guide for the development of the course.

Additional information
The course includes about 20 lectures. Expert (guest) teachers from industry or other academic institutions will contribute to the course.

The course is given jointly with Chalmers University of Technology. The Chalmers code for the course is TIF165.