FSH3500 Non-Proliferation of Nuclear Materials 6.0 credits

Icke-spridning av kärnmaterial

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for FSH3500 valid from Spring 2019

Grading scale

P, F

Education cycle

Third cycle

Specific prerequisites

The course is aimed for PhD students in nuclear engineering. Thus, reactor physics (such as SH2600) is a prerequisite. It is helpful if you are familiar with unix command line environments and computational algebraic systems such as Mathematica, Maple or Matlab.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

Man-made fissile materials in their purest form can be used to design global disasters. It is thus an inseparable task of any nuclear engineer to judge the political and environmental consequences of the availability of weapons grade materials. Furthermore, she is to ensure a negative contribution to the proliferation threat through appropriate engineering.

Course contents

By succeeding in the social sciences section of this class you will be able to:

- highlight the historical turning points that have lead countries to possess nuclear weapons and envisage counteractive measures for the future
- justify the costs of protecting fissile material while questioning the amplitude of fear leading to irrational investments

By succeeding in the engineering section of this class you will be able to:

- apply the underlying physics and material science of triggering rapid chain reactions, in order to clarify which fissionable isotopes are subject to non-proliferation concerns
- apply the underlying chemistry of actinide separation, in order to clarify if and how chemical plant design can be used to reduce the availability of weapons grade materials.
- select reactor designs which minimise the production of weapons usable materials

Disposition

An intrinsic objective of the course is to train skills necessary for working as a scientist and engineer who can argue for choices made from non-proliferation perspectives by performing necessary calculations. Thus the final assessment will be formulated as a research task, which is to be delivered in the form of a conference paper, an oral presentation and a debate. Passing the course typically means you have attended 20 hours of meetings and performed 110 hours of work in your office. Most effort is thus to be done out of class.

Course literature

- F. Barnaby: The invisible bomb - the nuclear arms race in the Middle East. I.B.Tauris & Co Ltd, 1989.
- C. Bathke et al, Further assessments of the attractiveness of materials in advanced nuclear fuel cycles from a safeguards perspective, Proc 10th IEMPT, Mito, Japan, October 2008.
- J. Carson Mark, Explosive properties of weapons grade plutonium, Science & Global security 4 (1993) 111.
- J. Carson Mark, Reactor grade plutonium's explosive properties, NPT 95, Nuclear Control Institute.
- G. Kessler, Proliferation resistance of americium..., Nuclear Science and Engineering 159 (2008) 56.
- G. Kessler, Proliferation-Proof Uranium/Plutonium Fuel Cycles, KIT scientific publishing, ISBN 978-3-86644-614-4.
- www.nuclearweaponarchive.org

Examination

- UPP1 - Report, 2.0 credits, grading scale: P, F
- INL1 - Assignments, 2.0 credits, grading scale: P, F
- SEM1 - Seminar, 1.0 credits, grading scale: P, F
- TEN1 - Oral exam, 1.0 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

The home assignments are designed in a way to ensure that all course objectives are included.

1) A 3-4 page essay on ”Can mistakes made yesterday help to prevent the proliferation of nuclear materials today?” The essay will be peer reviewed and then assessed by the teacher.

2) A debate on the proliferation risks associated to a particular reactor system. Groups of 2-3 people are assigned a task to either defend Generation III or Generation IV systems from the perspective of non-proliferation. The respective groups are then to present their positions to each other and defend their opinions based on their learning outcomes.

3) A computational exercise involving calculations of alpha-eigenvalues, neutron emission rates and heat production for actinide compositions present in spent fuel of various reactor types. The result of the exercise is an assessment of to what extent the assigned materials and reactor types are of concern for non-proliferation matters, with or without chemical separation of minor actinides.

Other requirements for final grade

This course is graded on a pass/fail scale. In order to pass you should:

- actively participate in all course meetings. If you cannot attend a meeting, report this in advance, and you will be given an extra written assignment to replace the meeting you missed.
- deliver all home assignments according to the description below
- have an individual discussion with the teacher about the contents of the home assignments over 30-40 minutes. The discussion is considered to be successful if you meet all of the above stated course objectives.

Ethical approach

- All members of a group are responsible for the group's work.

- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.