"Hydropower – Technology, Economy, Sustainability"

Period 3, VT 2024, 7.5 credits

All updates will be reported in class and in Canvas (see home page and announcements)

Course coordinator	**Course examiner**	**Course lecturers**
Vladimir Kutcherov	Cali Nuur	Vladimir Kutcherov Thomas Sandberg Mikael Sundby Lennart Söder Bo Pettersson Erik Byström Maria Morgunova Frauke Urban

Learning outcomes (ILO)

After this course the student should be able
ILO1. To demonstrate the role of hydropower in the energy system, in Sweden and internationally
ILO2.To compare design of dam, power station, mechanical, electrical and electronic equipment
ILO3.To analyze innovation aspects of hydropower
ILO4.To formulate the economic conditions for and consequences of hydropower
ILO5.To debate the environmental impact of hydropower and the legal conditions for hydropower
ILO6.To analyze a problem dealing with hydropower industry and describe it in the individual report.

Course main content

The main focus is how the hydrological conditions determine the physical and technical design as well as the operation of a hydropower station, and which the economic and environmental consequences will be. The course covers many subject areas, which are treated more thoroughly in other courses offered by the departments cooperating in this course. Here follows an overview of the content where the lectures are allocated to the different areas.

Module 1: INTRODUCTION (ILO1)
Module 2: TECHNOLOGY (ILO2, ILO3)
Module 3: ECONOMICS (ILO4)
Module 4: SUSTAINABILITY (ILO5)

Seminars (ILO6)
The seminars are the key elements of the course. The participation is mandatory.

Both seminars **S1** and **S2** are related to the individual project and require submissions beforethe seminars. The submissions include the **individual assignment** before each seminar (project proposal **D1** and final submission **D2**) and peer-review feedback on two peer projects in canvas before the seminarand questions during the seminar. This means that you will need to read two projects of your peers beforeeach of the seminar and prepare some comments and questions.

The students are strongly advised to work continually with the individual project during the course

to distribute the workload.

In total, there are **two seminars** in the course and **two deadlines**:

- The **seminar S1** "presentation of proposals" is dedicated to you project proposals presentations on the chosen topic. The **deadline D1** for the project proposal submission is 31.01.2020 23:59.
- On the **seminar S2** "final presentation" you will present your final project proposals. **The corresponding deadline** is **D2** on 24.02.2020 23:59. After this seminar you will have time to improve your individual project and submit the final version of the paper.

Submissions requirements:

- **D1** written assignment, 1-2 pages excl. pictures and reference list.
- **D2 max 5 pages** project excl. pictures and reference list.
- Additionally, **peer-review feedback** to be submitted via canvas before the seminar.

All the submissions are kindly asked to be submitted in .**doc**, .**docx** or .**pdf** format 12 type, 1.5 space.Graphic material, tables, calculations, appendixes or any other data are welcome in addition to therequired text volume.

All the submissions must be done through Canvas (assignments page) and will be checked for plagiarism.

Study visits

Two study visits (mandatory), one at Fortum in Stockholm and the another in hydropower plants in Älvkarleby will be arranged.

Grading

Grading consists of two parts: submitted individual report and written exam.

The students who didn't submitted the final version of the individual report are not allowed to take the exam.

Grading criteria for the individual report (ILO 6)

The students will be given individual grades (A-F) according to the description below. No final grade is given if the individual report has an F.

A • Potentially publishable after minor amendment and/or improvement to presentation • Ability to plan, organise and execute independently a research project to the highest standards • Ability to analyse data critically to the highest professional and academic standard • Highest standards of competence, written expression, and presentation

B • Includes content that is original and potentially publishable after significant amendment and/or improved presentation • Ability to plan, organise and execute independently a research project to a high standard • Ability to analyse data critically and to a high standard • High standards of competence, written expression and presentation

C • Evidence of capability to undertake original research given appropriate guidance and support • Flexibility of thought, and the ability to solve complex, though not entirely original research problems • Ability to evaluate published or publicly-presented work and to analyse critically sources of literature and information • Ability to analyse data critically • Professional standard of competence, expression and written presentation

D • Adequate knowledge and understanding of the relevant literature and other key sources of information • Ability to construct coherent and relevant responses to research questions, though with few signs of originality • Some ability to analyze critically sources of literature and information • Ability to engage in research when provided with supervision and support • A competent level of organization and written expression • Satisfactory degree of technical accuracy

E • Some knowledge and understanding of the essential literature and other key sources of information, but arguments are either incomplete or not entirely coherent • Limited grasp, or inadequate specification, of the research problem or topic • Poor formatting, style, presentation and referencing • Work which is just enough for an acceptable professional standard

Fx • Fragmentary knowledge and understanding of the essential literature and other key sources of information • Shows little or no grasp of a clear research problem or topic • No evidence of independent or original thought • No attempt to analyse data or present results in scientific manner • Confused written presentation • Inadequate formatting, style, presentation and referencing • Work that is below an acceptable professional standard

F • A short submission with no knowledge and understanding of the literature or topic • No independent thought or analysis • Incoherent written presentation • Wholly improper formatting, style, presentation and referencing

Grading criteria for exam

The written exam is the end point of the course. The exam consists of four groups of questions corresponding to the blocks of the course and outcomes. A student should get at least 50% of points in each module. For grade Fx a student should get at least 50% of points in three modules and not less than 40% in one module.

The students will be given individual grades (A-F) according to Table below. No final grade is given if the exam has an F.

Final grade	Amount of point received in exam, %
A	90-100
B	80-90
C	70-80
D	60-70
E	50-60
Fx	50 in three modules, 40 in one module
F	< 50 in at least two modules

Final grade

Final grade according to table below. No final grade is given if either of the seminars or exam has an F.

Submitted individual report	Exam				
	A	B	C	D	E
A	**A**	**B**	**B**	**C**	**D**
B	**A**	**B**	**C**	**C**	**D**
C	**B**	**B**	**C**	**D**	**D**
D	**B**	**C**	**C**	**D**	**E**
E	**C**	**C**	**D**	**D**	**E**

The students who will take part in all lectures/seminars/study visits will get five additional points on the exam (the total amount of points on the exam is 58).

Literature:

There will be changes in the literature but as an information we show the literature from last year.

Wagner, H-J & Mathur, J, 2011, Introduction to Hydro Energy Systems. Springer Verlag, Berlin Heidelberg. 1 – 94, 111 – 126. (Electronically available as e-book at KTHB).

Kumar, A, Schei, T m fl, 2011, Hydropower. Chapter 5 i Ederhofer, O m fl, IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Cambridge University Press, Cambridge and New York. 54 pages. (Electronically available on internet).

Söder, L, Planning and operation for an efficient production-load balance. Part of course literature in

Power market analysis. 11 pages. (Electronically available in the course).

Söder, L, 2015, System studies of Sweden with close to 100 % renewable power supply. Submit-ted article. 18 pages. (Available as paper copy in the course).

Hydro Power as a Balance Resource", NEPP Synthesis results. 2 pages. (Electronically available on http://nepp.se/pdf/hydro_power.pdf)

Penche, C m fl, 2004, Guide on how to develop a small hydropower plant. Chapter 6 Electromechanical equipment. European Small Hydropower Association, Brussels. 125 – 168. (Electronically available in the course).

ASME Hydro Power Technical Committee, 1996, The Guide to Hydropower Mechanical Design. American Society of Mechanical Engineers, H C I Publications. 275 pages. Only some parts according to later instructions.

Penche, C m fl, 2004, Guide on how to develop a small hydropower plant. Chapter 6 Electromechanical equipment. European Small Hydropower Association, Brussels. 125 – 168. (Electronically available in the course).

Penche, C m fl, 2004, Guide on how to develop a small hydropower plant. Chapter 8. Economic analysis. European Small Hydropower Association, Brussels. 203 – 223. (Electronically available in the course).

Försund, F, 2007, Hydropower Economics. Chapter 10. Summary and Conclusions. Springer, New York. 239 – 249. (Electronically available as e-book in KTHB).

International Energy Agency (IEA), 2012, Technology Roadmap: Hydropower. IEA, Paris. 38 – 56. (Electronically available as e-book at KTHB and on internet).

Baxter, R M, 1977, Environmental effects of dams and impoundments. Annual Review of Ecology and Systematics, vol 8, pp 255 – 283. (Electronically available in the course).

ICOLD, 2000, Position paper on dams and environment. 10 pp. (Electronically available in the course).

Penche, C m fl, 2004, Guide on how to develop a small hydropower plant. Chapter 7. Winemiller, K et al, 2016, Balancing hydropower and biodiversity in the Amazon, Congo, and Mekong. Science, vol 351, pp 128 – 9. (Electronically available in the course and on internet).

Schedule

This schedule replaces the one on kth webpage. Please note that due to many guest lectures the schedule may be a subject to change. All updates in the schedule will be reported on Canvas (check schedule and announcements pages).

#	type	week	day	room	time	topic	Lecturer
1	lecture	v3	Tuesday 16/1	243 SingSing	13-15	Introduction to the course / Introduction to the projects. Role of hydropower in the global energy system transition	VK
2	lecture	v3	Thursday 18/1	243 SingSing	13-15	Hydropower in Sweden and the world, both big and small	TS
3	lecture	v4	Monday 22/1	243 SingSing	10-12	Hydrology	Mikael Sundby
4	Study visit	v4	Tuesday 23/1	Fortum	8-16	Study visit to Fortum, Stockholm	VK
5	lecture	v4	Tuesday 25/1	243 SingSing	13-15	Hydropower dispatch	Lennart Söder
6	lecture	v5	Monday 29/1	243 SingSing	13-15	Turbines and other mechanical equipment (part 1)	Bo Pettersson
7	lecture	v5	Tuesday 30/1	243 SingSing	13-15	Turbines and other mechanical equipment (part 2)	Bo Pettersson
D1	deadline	v5	Wednesday 31/1	Canvas	23:59	project proposal	
8(S1)	seminar	v5	Thursday 1/2	243 SingSing	13-15	Seminar: Presentation of proposals	VK
9	lecture	v6	Monday 5/2	243 SingSing	13-15	Generators, other electric and control equipment (part 1)	Erik Byström
10	lecture	v6	Tuesday 6/2	243 SingSing	10-12	Generators, other electric and control equipment (part 2)	Erik Byström
11	lecture	v6	Thursday 8/2	Online	13-15	Introduction to Industrial Dynamics: hydropower in focus	Maria Morgunova
12	lecture	v7	Monday 12/2	Online	13-15	Hydropower TIS in contexts	VK
13	Study visit	v7	Wednesday 14/2	Älvkarleby	8-16	Study visit to the hydropower plant, Älvkarleby	VK
14	lecture	v7	Thursday 15/2	243 SingSing	10-12	Economy (part 1)	TS
15	lecture	v8	Monday 19/2	243 SingSing	13-15	Economy (part 2)	TS
16	lecture	v8	Tuesday 22/2	Online	10-12	Technology transfer and cooperation for large hydropower plants	Frauke Urban
17	lecture	v8	Tuesday 22/2	243 SingSing	13-15	Project proposal consultation	VK
D2	deadline	v8	Wednesday 23/2	Canvas	23:59	case seminar feedback	VK
18	Lecture	v9	Monday 26/2	243 SingSing	10-12	Local natural environment (part 1)	Anders Wörman
19 (S2)	seminar	v9	Tuesday 27/2	243 SingSing	8-12	Seminar: final presentation	VK
20	lecture	v9	Wednesday 28/2	243 SingSing	13-15	Local natural environment (part 2)	Anders Wörman
21	lecture	v9	Thursday 29/2	243 SingSing	13-12	Water law	TS
22	exam	v10	Thursday 8/3	You will be informed	8-12	exam	VK

legend: lecture | seminar | deadline | exam | guest lecture | Study visit