CIVIL-469

Hydropower schemes and pumped-storage

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Cursus	Sem.	Type
Civil Engineering	MA2, MA4	Opt.
Civil engineering minor	E	Opt.
Energy Science and Technology	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The course deals with the conception and design of hydraulic structures used for production and/or storage of electric energy, including pumped hydro energy storage (PHES). We discuss their technical/social/economical/environmental feasibility in the Swiss/European/Global energy transition.

Content

- Assess the hydropower potential of a river reach
- Distinguish the typology of hydropower schemes
- Feasibility Design of small-hydropower schemes
- Conceive low-head, mid-head and high-head schemes with/without storage
- Assess the value of energy storage by pumping
- Conceive hydropower batteries (pumped-storage), general layout and equipment.
- Conceive pressurized hydraulic tunnels and shafts
- Conceive measures against waterhammer, design of surge tanks.
- Conceive water intakes in rivers, reservoirs and natural lakes
- Define construction strategies to manage flood risks during construction
- Adopt value-engineering measures to mitigate hydropower footprint on natural systems

The conception and design of hydraulic structures for hydropower implies using multiple skills to handle fluid-structure interactions, rock mechanics, design optimisation considering environmental, technical and socio-economic factors.

Keywords

Hydropower plants and batteries; hydropower potential, renewable energy, hydraulic tunnels & shafts, surge tanks, river diversion during construction, water intakes.

Learning Prerequisites

Required courses

Fluid Mechanics
Hydrology
Hydraulics Works & Schemes
Strength of Materials

Recommended courses

Rock Mechanics
Concrete Structures & Steel Structures

Important concepts to start the course

Basic fluid mechanics such as hydrostatics, free surface flows and pressurized flows
Basic principles of hydrology such as rainfall-runoff processes
Basic principles of hydraulics such as weir design, hydraulic jump, energy losses
Basic strength of materials such as stresses, displacements, stiffness
Economic optimisation principles such as cost and revenue estimate and analysis

Learning Outcomes

By the end of the course, the student must be able to:

- Assess / Evaluate different types of hydropower schemes
- Assess / Evaluate the hydropower potential in a given territory with and without storage
- Design the main components of hydropower schemes
- Optimize the layout and design of the main components of hydropower schemes

Transversal skills

- Use a work methodology appropriate to the task.
- Take responsibility for environmental impacts of her/ his actions and decisions.
- Respect relevant legal guidelines and ethical codes for the profession.
- Demonstrate a capacity for creativity.
- Demonstrate the capacity for critical thinking
- Write a scientific or technical report.

Teaching methods

Ex cathedra, exercices, case studies.

Expected student activities

Handover of min 4 exercices, active contributions to ex-cathedra courses

Assessment methods

Continuous assessment during the semester.
Handover of min. 4 exercices : 50 %
Mid-term test and final written test during exam session : 25% + 25%.

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes
Others	To be confirmed during first week of semester (e.g. field visit)

Resources

Virtual desktop infrastructure (VDI)

Yes

Bibliography

TGC 15 "Constructions Hydrauliques" de W. Hager et A. Schleiss, PPUR, 2009

Ressources en bibliothèque

- Constructions hydrauliques / Hager et Schleiss (TGC 15)

Notes/Handbook

Hydropower plants and pumped-storage, Dr. G. De Cesare & Dr. P. Manso [In English, 2024, two volumes]
Aménagements hydroélectriques, Dr. G. De Cesare & Dr. P. Manso, 2020 [In French]

Prerequisite for

Master thesis in Hydraulic Structures, Renewable Energies, Tunnel Engineering, Dam Engineering