

ME-453

**Hydraulic turbomachines**

Avellan François, Vagnoni Elena

<b>Cursus</b>	<b>Sem.</b>	<b>Type</b>
Energy Management and Sustainability	MA1, MA3	Opt.
Energy Science and Technology	MA1, MA3	Obl.
Energy minor	H	Opt.
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.
Mechanics		Opt.
Nuclear engineering	MA1	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Written
Workload	120h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	3 weekly
Exercises	1 weekly
<b>Number of positions</b>	

**Summary**

Master lecture on Hydraulic Turbomachines: impulse and reaction turbines, pumps and pump-turbines.

**Content**

- Turbomachine equations, mechanical power balance in a hydraulic machines, moment of momentum balance applied to the runner/impeller, generalized Euler equation.
- Hydraulic characteristic of a reaction turbine, a Pelton turbine and a pump, losses and efficiencies of a turbomachine, real hydraulic characteristics.
- Similitude laws, non dimensional coefficients, reduced scale model testing, scale effects.
- Cavitation, hydraulic machine setting, operating range, adaptation to the piping system, operating stability, start stop transient operation, runaway.
- Reaction turbine design: general procedure, general project layout, design of a Francis runner, design of the spiral casing and the distributor, draft tube role, CFD validation of the design, design fix, reduced scale model experimental validation.
- Pelton turbine design: general procedure, project layout, injector design, bucket design, mechanical problems.
- Centrifugal pump design: general architecture, energetic loss model in the diffuser and/or the volute, volute design, operating stability.

**Learning Prerequisites****Recommended courses**

Incompressible Fluids Mechanics  
Introduction to turbomachines

**Learning Outcomes**

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

- Formulate the operating point of a hydraulic turbomachine
- Specify a type of hydraulic turbine
- Sketch the layout of a hydraulic turbomachine
- Select appropriately the dimensions of a hydraulic turbomachine

**Transversal skills**

- Use a work methodology appropriate to the task.
- Communicate effectively with professionals from other disciplines.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.

### Teaching methods

ex cathedra lectures with working case studies

### Expected student activities

attendance at lectures completing exercises and reading written material

### Assessment methods

written exam

### Resources

#### Bibliography

P. HENRY: Turbomachines hydrauliques - Choix illustré de réalisation marquantes, PPUR, Lausanne, 1992.

Franc, Avellan et al., Cavitation, EDP Grenoble, 1994

Handout and Scientific Literature from LMH, Industry, International Association

#### Ressources en bibliothèque

- [Turbomachines hydrauliques / Henry](#)
- [Cavitation / Franc](#)

#### Notes/Handbook

slides handout Handbook

### Prerequisite for

Cavitation, Hydroacoustic, Master Project