

CIVIL-427

Flow monitoring technology in water engineering

Cursus	Sem.	Type
Civil Engineering	MA2, MA4	Opt.
Civil engineering minor	E	Opt.

Language of teaching	English
Credits	3
Session	Summer
Semester	Spring
Exam	During the semester
Workload	90h
Weeks	14
Hours	3 weekly
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Remark

Pas donné en 2024-25

Summary

This course aims to provide theoretical fundamentals in flow measurement science, and advanced knowledge regarding measurement methods, tools and instrumentation applied to experimental hydraulics, industrial and environmental flows and water engineering applications.

Content

This course concerns as well hydrometry as the science and technologies used for quantitative measurement and monitoring of hydraulic quantities in natural and constructed/human made flows. Such flow measurements are essential for hydrologic sciences and for sustainable management of water resources and natural hazards. Flow measurement technologies applied in modern laboratory experiments (for process oriented fluid mechanics studies) and in field experiments (for river monitoring purposes) will be explained in terms of measurement principle, method, capability, performance (resolution, accuracy, uncertainty) and limitations. The chapters of the lecture are organized in type of measured quantity after a first introduction chapter reminding the required theoretical notions in hydrodynamics, turbulence and boundary layer flows, signal theory and signal processing. Chapter 2 presents flow velocimetry including existing hydroacoustic and optical technologies. Chapter 3 addresses river discharge monitoring for water resources management, network surveillance and flood risk mitigation. Chapter 4 concerns sediment transport measurements and corresponding instrumentation for laboratory and field experiments. Chapter 5 explains measurement of hydraulic bulk flow quantities as flow depth, the bed slope, the free-surface slope, the flow bathymetry. A practical lab session will be accomplished by the students on an experimental facility of the EPFL hydraulic platform, nearby river or lake.

Contenu

- Introduction (Flow conservation equations, RANS equations, Exner equation, boundary layer flow properties, turbulence, basic signal theory & processing notions, digital twins of fluid flow infrastructure, etc.)
- High resolution flow measurement tools (Doppler Effect, Image correlation based, transit time, ADV, ADCP, UDV, ADVP, LDA, LDV, PIV, PTV)
- River discharge monitoring (velocity-index method, transit-time, gauging methods with Doppler radars, Large-scale PIV, ADCP gauging)
- Sediment transport measurements (Grain size distribution, Suspended load, bedload, Sediment flux)
- Hydraulic bulk flow quantity measurement (Water Depth and pressure, Water surface slope, bed slope, bed shear stress, bathymetry, bedforms), both stationary and transient

- Stream temperature and heat flow patterns via invasive and non-invasive sensors
- Heat-exchange sensors for vegetation sap flow activity

Keywords

Hydraulics, fluid mechanics, flow measurement science and technology, instrumentation, PIV, PTV, ADCP, ADV, UVP, ABS. Digital Twins and AI

Learning Prerequisites

Recommended courses

Fluid mechanics, basic notions in signal theory and processing

Learning Outcomes

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

- Interpret understand the principle, performances and limitations of existing flow measurement technologies
- Perform design a river flow monitoring station, gauging campaign using contemporary instrumentation
- Quantify Select and apply appropriate flow instrumentation for specific hydraulic experiments conducted in laboratory and field conditions
- Contextualise process, analyze and interpret experimental hydraulics data
- Design
- Assess / Evaluate
- Choose

Transversal skills

- Access and evaluate appropriate sources of information.

Teaching methods

Ex cathedra, exercices, TP

Expected student activities

Practical lab and data treatment work

Assessment methods

50% exercises, practical lab work and data treatment, report and presentation

50% written exam during exam session

Supervision

Office hours	Yes
Assistants	Yes
Forum	No

Resources

Bibliography

IAHR monograph: Experimental Hydraulics: Volume II: Instrumentation and measurement techniques. CRC

Press, 2017

Ressources en bibliothèque

- [Experimental Hydraulics: Volume II: Instrumentation and measurement techniques](#)

Notes/Handbook

Handouts, notes and slides during class

Coursebook "Flow Measurement Science & Technology" by D. Hurther