CIVIL-410

Fluvial hydraulics and river engineering

Musa Mirko

Cursus	Sem.	Type
Civil Engineering	MA1, MA3	Opt.
Civil engineering minor	H	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	1 weekly
Project	1 weekly
Number of positions	

Summary

The course provides core principles of river engineering for planning and designing restoration and flood-protection measures, focusing on sediment transport, hydro-morphodynamics, flood hazard assessment, and common river-engineering structures.

Content

- Review of watershed hydrology: precipitations, flow duration curves, flood frequency analysis, extreme floods
- Review of fluid mechanics and open channel hydraulics: 1D/2D equations, uniform flow, gradually varied flow, rapidly varied flow (hydraulic jump), turbulence, etc.
- Sediment transport: sediment characteristics, physical processes, process modeling (hydrodynamic equations, bedload transport, suspended-load transport, total transport), bedforms, morphodynamics.
- River training and river-protection measures; bank protection and bed stabilization against erosion.
- Design of river works and flood-protection measures. Hazard analysis and protection objectives.
- Legal framework, Sustainability and management of the resources, and integrated Risk management.

Keywords

Fluvial hydraulics, sediment transport, river training, morphodynamics, river restoration, river management, water quality

Learning Prerequisites

Required courses

Fluid Mechanics, Hydraulic Analysis and Design (CIVIL 312)

Recommended courses

Hydrology for Engineers

Important concepts to start the course

Fluid mechanics fundamentals, open channel hydraulics, intro of informatics and programming

Learning Outcomes

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

- Derive and understand the fundamental theories behind fluvial hydraulic: sediment transport, hydraulic engineering, morphodynamics.
- Design the most common structures in river engineering (channel stabilization, planimetry, flood control, etc.).
- Assess / Evaluate The health and safety of a river system and plan sustainable restoration.
- Formulate a reliable and sustainable river protection project.
- Judge the hydro-morphodynamic processes that govern the planform and vertical evolution of river channels, and the assessment of their dependence on the controlling physical parameters.
- Quantify flood risk and assess protection/mitigations measures.
- Analyze the conditions under which different river forms develop, and how to estimate the magnitude of erosion and deposition processes as well as their likely evolution over time.
- Develop numerical modelling for the resolution of group projects.

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Set objectives and design an action plan to reach those objectives.
- Demonstrate a capacity for creativity.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Take feedback (critique) and respond in an appropriate manner.
- Communicate effectively, being understood, including across different languages and cultures.
- Give feedback (critique) in an appropriate fashion.
- Respect relevant legal guidelines and ethical codes for the profession.

Teaching methods

- 3 hours of weekly lectures ex-cathedra, with a mix of projected material and blackboard derivations
- 2 hours of weekly exercises or project preparation
- Preparation of a final group project carried out using numerical tools seen in class (e.g., BASEMENT, Delft 3D, HEC-RAS, etc.)
- Field trip (if time and organization allows)

Expected student activities

- Regular attendance to classes and exercise sessions
- Active engagement during classes and exercise sessions by asking questions
- Home study
- Completion of the group project and present findings

Assessment methods

- 40% project execution and final written report (in groups)
- 60% final oral exam (during the exam session)

- The oral exam covers an individual presentation of the project/report as well as a set of theoretical questions on the material covered in class

Resources

Bibliography

Aronne Armanini, "Principles of River Hydraulics." Springer, 2018. ISBN 978-3-319-68099-6.
Pierre Julien, "River mechanics." Cambridge, United Kingdom: Cambridge University Press, 2018. ISBN 978-1-107-46277-9. DOI: 10.1017/9781316107072
Ellen Whol, "Rivers in the Landscape, 2nd Edition", Wiley-Blackwell, 2019. ISBN: 978-1-119-53543-0.
Marcelo Garcia, "Sedimentation engineering: processes, measurements, modeling and practice." American Society of Civil Engineers, 2008. ISBN-13: 978-0-7844-0814-8

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