POLITECNICO MILANO 1863
DIPARTIMENTO DI INGEGNERIA CIVILE E AMBIENTALE

Control Valve Technologies

fluid lab
www.fluidlab.polimi.it

Overview: This course delves into the mechanics and applications of hydraulic control valves, a critical component in fluid management for various industrial systems. Students will explore fundamental fluid dynamics, valve characterization, and key phenomena like cavitation and noise generation. Combining theoretical insights with hands-on lab work and practical exercises, this course equips students with the knowledge needed to effectively design, analyze, and apply hydraulic valves in industrial contexts.

Key Topics:

1. **Fundamentals of Hydraulic Systems (8 ore)**
    - Recap of essential fluid dynamics principles:
      Bernoulli's equation, Reynolds number, and throttling processes in both compressible and incompressible flows.
    - Introduction to the concept of self-similarity in fluid mechanics.
2. **Valve Characterization and Industry Standards (6 ore)**
    - Valve performance parameters (Cv, FL, σ, xt) from theoretical standards to real-world applications.
    - Flow regimes and their impact on valve selection and operation.
    - Understanding flow coefficients and the impact on valve selection and design.
3. **Critical flows (6 ore)**
    - Physics of cavitation: causes, effects, and how it influences valve performance and how to mitigate its effects.
    - Compressible choked flow in valves: understanding sonic and subsonic regimes.
4. **Noise Emission in Hydraulic Valves (3 ore)**
    - Identification and analysis of noise sources in valve systems.
    - Techniques for noise measurement and reduction strategies in industrial environments.
5. **Numerical methods (3 ore)**
    - Overview of most used numerical methods for the prediction of valve performances

Laboratory Work:

- **Noise Analysis on Perforated Plates (Air Loop) (3+2 ore)**
  Students will perform noise measurements to analyze how perforated plates influence acoustic emissions in fluid systems.
- **Needle Valve Characterization (E-Loop) (3+2 ore)**
  Hands-on lab activities focusing on the characterization of needle valves in controlled settings.

Practical Exercises:

- **Valve Sizing Calculations (2 ore)**
  Students will conduct sizing exercises for valves handling both compressible and incompressible fluids, including low Reynolds number corrections on real cases.
- **Valve Working Area Mapping (2 ore)**
  Creation of valve performance curves and working area diagrams based on characteristic parameters.

Assessment:

- **Oral Examination**
  Students will present their solutions to the exercises and submit a lab report detailing their findings, followed by an oral exam discussing their work and comprehension of the course material.

SCHEDA DETTAGLIATA INSEGNAMENTO
COURSE OBJECTIVES
By the end of this course, students will have a solid understanding of the principles governing hydraulic valves and their industrial applications. They will learn to analyze and calculate key performance parameters, select and size valves for different flow conditions, and understand the effects of critical phenomena like cavitation and noise. Through hands-on labs, students will gain practical skills in measuring valve performance and flow measurements.

RISULTATI DI APPRENDIMENTO ATTESI
Knowledge and ability in understanding:
- recognize and define the basic features of a fluid dynamic process.
- comprehension of fluid dynamics as it relates to hydraulic valves, including valve characterization, flow phenomena, and noise management, enabling them to design, optimize, and troubleshoot industrial valve systems effectively

Ability in applying knowledge and understanding:
- make use of engineering tools in data analysis
- be able to apply their theoretical knowledge to real-world scenarios, performing valve sizing, analyzing performance data, and conducting practical experiments to solve industrial fluid control challenges efficiently

Making judgments:
- ability to critically evaluate valve performance, diagnose issues like cavitation and noise, and make informed decisions on valve selection, design adjustments, and maintenance strategies in complex industrial systems.

Communication skills:
- ability to clearly present technical concepts, lab results, and design solutions, both in written reports and oral presentations, effectively communicating complex hydraulic valve issues.

Learning ability:
- managing laboratory work

ARGOMENTI TRATTATI

The course focuses on hydraulic valves, covering essential principles of fluid dynamics and their application to valve characterization. Students will investigate cavitation effects, noise emissions, and advanced flow control techniques specific to valve systems. Hands-on laboratory work emphasizes measuring noise levels and analyzing valve performance. Additionally, the course addresses material selection, maintenance strategies, and design considerations, equipping students with the skills needed to design, optimize, and troubleshoot hydraulic valve systems effectively in industrial applications.

OBIETTIVI DI SVILUPPO SOTENIBILE

- SDG9 - INDUSTRY, INNOVATION AND INFRASTRUCTURE

PREREQUISITI

Fundamentals of: hydraulics and fluid mechanics; dimensional analysis.

MODALITà DI VALUTAZIONE

Students will present their solutions to the exercises and submit a lab report detailing their findings, followed by an oral exam discussing their work and comprehension of the course material.