Area: Hydraulic, Water Resources and Environmental Engineering

Level: PhD

Course title: Viscous Fluid Flow

Lecturer: M. Spasojevic

Course objective:

Gain theoretical background in viscous fluid flows, governing equations, analytical solutions etc.

Course outline

Course topics

Governing equations of fluid mechanics
- Basic principles (properties of fluids, rotation and deformation of fluid elements, etc.)
- Conservation principles – Reynolds transport theorem
- Conservation of mass, momentum and energy
- Mathematical character of governing equations
- Dimensionless parameters

Incompressible viscous fluid flows
- Classical analytical and numerical solutions – laminar flows (steady flow between parallel plates, steady and unsteady duct flows, unsteady flows with moving boundaries, etc.
- Laminar boundary layers (governing equations, solution methods, applications)
- The stability of laminar flows (laminar layers), transition to turbulence
- Incompressible turbulent fluid flows
  - Reynolds equations, Reynolds-stress transport equations, turbulence models
  - Semi-empirical considerations of turbulent flows, velocity profiles, low of the wall, etc.
  - Turbulent flows in pipes and channels
  - Turbulent boundary layer on a flat plate
  - Turbulent jets and wakes
  - Integral analysis of boundary layers with pressure gradient

Brief introduction to compressible viscous fluid flows

Assignments and term projects

Course topics are accompanied by assignments and term projects, requiring individual work under teacher's guidance and supervision.

Recommended literature:

1. F. M. White: *Viscous Fluid Flow*, McGraw-Hill, Inc. 1974.
2. G. Hajdin: *Fluid Mechanics - Part 1 - Fundamentals*, Civil Engineering Faculty Belgrade, 2002, in Serbian.
3. G. Hajdin: *Fluid Mechanics - Part 2 – Introduction to Hydraulics*, Civil Engineering Faculty Belgrade, 2002, in Serbian.
4. I. G. Currie: *Fundamenal Mechanics of Fluids*, 2nd ed., McGraw Hill, Inc. 1993..
5. C. S. Yih: *Fluid Mechanics*, Corrected edition, West River Press, 3530, West Huron River Drive, Ann Arbor, Michigan 48103, U.S.A, 1973.