

Faculty of Applied Sciences



AUCE1152 Hydraulic

[30h+30h exercises] 5 credits

This course is taught in the 2nd semester

Teacher(s): Yves Zech
Language: French
Level: First cycle

Aims

- Initiation to hydraulics fundamentals from continuous mediums mechanics
- Theoretical and practical approaches of major problems of pressure (pipes) and free-surface (canals and sewers) flow
- Introduction to transient problems

Main themes

- Hydrostatics
- Basic equations and flow models
- Orifices et weirs
- Pressure pipes

Content and teaching methods

- Introduction : domains of involvement of hydraulics, liquid properties, fundamental theorem about pressure (2 hours);
- Hydrostatics (4 hours) :
 - * Differential and integral equations,
 - * Manometers,
 - * Force component and centre of pressure on plane areas and curved surfaces,
 - * Statics and dynamics of submerged and floating bodies;
- Basic equations of hydraulics (2 hours) : Lagrangian et Eulerian approaches, displacement, deformation and rotation;
- Flow model :
 - * Perfect-liquid model (5 hours) :
kinematics of irrotational flows : streamlines and potential, complex potential, conformal transformations; applications to bridge piers in rivers, to weirs and to hydrodynamic profiles,
dynamics : Euler's equations, integral forms of Lagrange and Bernoulli;
 - * Viscous-liquid model (2 hours) :
Stokes assumption and Navier-Stokes equations,
laminar in pipes : velocity parabolic distribution and discharge integral (Poiseuille);
 - * Turbulent-liquid model (8 hours) :
turbulence : statistical approach, Reynolds analogy, Navier-Stokes-Reynolds-Boussinesq equations, mixing length (Prandtl)
velocity logarithmic distribution (smooth and rough turbulent cases),
head losses : dynamic similitude, friction losses in pipes (Darcy, Moody-Nikuradse), eddy losses;
 - * Application field of the models and selection of modelling assumptions
- Applications
 - * Liquid-wall interactions (2 hours)
Hydrodynamic forces,
Boundary layer;
 - * Orifices et weirs (2 hours)
 - * Closed conduits and pipe networks :
steady flow (3 hours) : simple pipes; branching pipes; networks of pipes : mesh method (Hardy-Cross), node method (Newton-Raphson),
transient flow (5 hours) : mass waterhammer; wave waterhammer : method of Bergeron, Alliévi's partial-derivatives equations, method of characteristics (simple pipes and networks);
 - * Free-surface flow : canals and sewers (10 hours)
uniform flow : Chézy and Manning equations, optimal section, compound and composite channels, uniform-depth calculation in canals and sewers,
gradually varied flow : specific energy, critical depth, critical slope, water profiles: theory et practical calculation
suddenly varied flow : hydraulic jump, submerged hydraulic jump,
elementary applications: upstream and downstream water profiles, changes in slope or in width.

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

- Obligatory topic for theme "Hydraulics"
- Prerequisite: "Mechanics of the continuous mediums"
- Pedagogy : courses, elementary exercises, lab on pipe flow
- Evaluation : written examination (exercises), oral examination (theory)

Other credits in programs

ARCH13BA	Troisième année de bachelier en sciences de l'ingénieur, orientation ingénieur civil architecte	(5 credits)
FSA12BA	Deuxième année de bachelier en sciences de l'ingénieur, orientation ingénieur civil	(5 credits)
FSA13BA	Troisième année de bachelier en sciences de l'ingénieur, orientation ingénieur civil	(5 credits)