AMCO2152 Hydraulics

[45h+30h exercises] 7 credits

This course is taught in the 2nd semester

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

Aims

- Initiation to hydraulics fundaments 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) :
kinématics 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

FSA3DS/GC	Diplôme d'études spécialisées en sciences appliquées (génie civil)	(7 credits)	
GC21	Première année du programme conduisant au grade d'ingénieur civil des constructions	(7 credits)	Mandatory