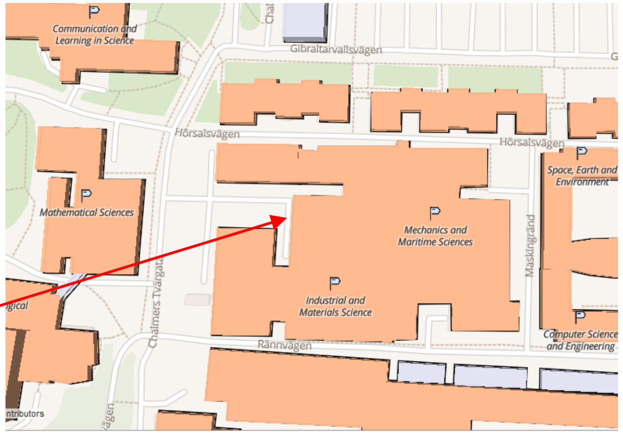
Welcome!



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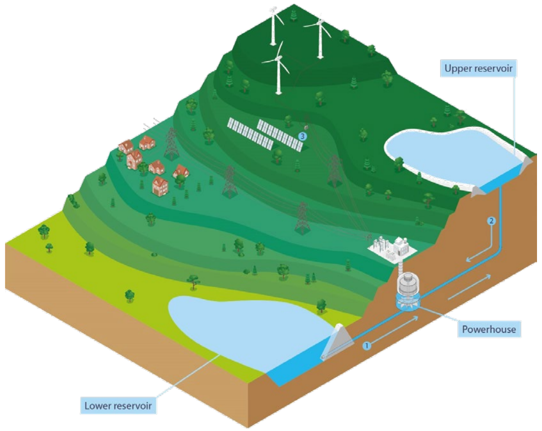
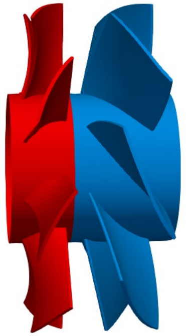
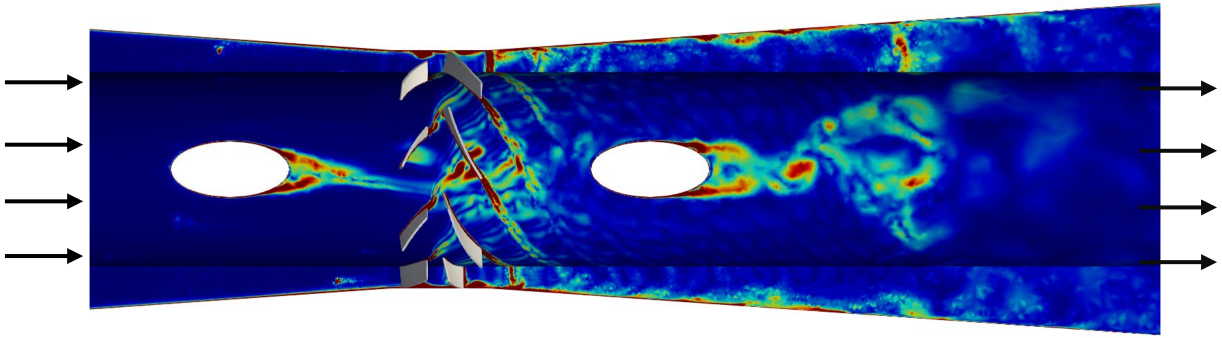
  - Fahlbeck@chalmers.se
  - PhD student at fluid mechanics since 2020, office at the 2nd floor
  - Previously worked as an engineer consultant with fluid calculations (CFD) at Semcon
  - My research concerns hydropower with a new type of pump-storage machine
    - Contra-rotating pump-turbine
    - ALPHEUS EU project







Practical suggestion in this course:

- Solutions to all home-tasks and exercises are available on canvas
  - Look there if you get stuck or wonder if your solution is correct.
- Study guide on canvas (theory questions)
  - Try to answer all the study guide questions (it well help you understand the content)
- The course contain 10 different areas. Try to keep track on which we are currently working with.
- Ask questions!
  - If you wonder about anything, than you neighbour is probably also doing it.
- Feedback, suggestions and remarks are always welcome!

Repeat some math!

- I use the following natation:
  - Scalar = a
  - Vector = $\tilde{a} = [a_x \quad a_y \quad a_z]$
- Scalar product = $\tilde{a} \circ \tilde{b}$
- Cross product = $\tilde{a} \times \tilde{b}$
- Nabla = $\tilde{\nabla}$ = $\left[\frac{\partial}{\partial x} \quad \frac{\partial}{\partial y} \quad \frac{\partial}{\partial z}\right]^T$
- Divergence: $\operatorname{div} \tilde{f} = \tilde{\nabla} \circ \tilde{f} = \frac{\partial f_x}{\partial x} + \frac{\partial f_y}{\partial y} + \frac{\partial f_z}{\partial z}$
- Gradient: $\tilde{\nabla}\tilde{f} = \left[\frac{\partial f_x}{\partial x} \quad \frac{\partial f_y}{\partial y} \quad \frac{\partial f_z}{\partial z}\right]^T$
- Velocity: $\tilde{v} = [u \quad v \quad w]$ in the directions $[x \quad y \quad z]$

Exercise 1.

- Fluid = liquid or gas (what we are working with in this course)
- Viscosity:
  - Material parameter for the fluid
  - Think about it as the fluids resistance towards shear
    - Compare with the friction coefficient between two solids
  - The higher the viscosity the greater the resistance
    - Syrup has high viscosity and water low
  - Dynamic viscosity: μ [kg/(m s)]

    Kinematic viscosity: $\nu = \frac{\mu}{\rho}$ [m²/s]

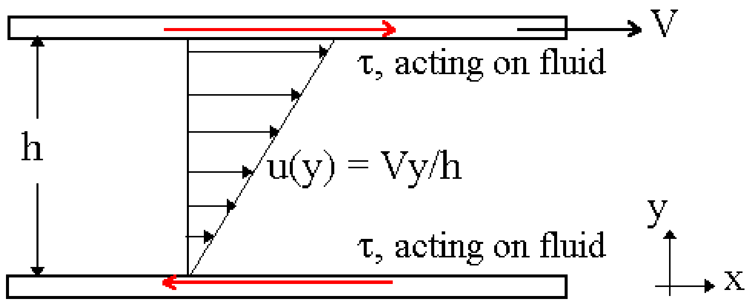
- Re-number: $\text{Re} = \frac{\rho U L}{\mu} = \frac{UL}{\nu} = \frac{\text{Inertia}}{\text{Viscous}}$ (1.24)

Exercise 1.

- Shear stress τ in a fluid (motion in *x* only)

$$\tau = \mu \frac{du}{dy} \qquad (1.23)$$

Fluid Viscosity ← μ; $\frac{du}{dy}$ → Velocity gradient in *y*-direction



- Total shear force on a surface:
  - $F = \int \tau \, \mathrm{d}A = \tau \, A$ (force = pressure x area)
- Energy required to move the plate:
  - $E = \int F \, \mathrm{d}L = F \, L$ (energy = force x distance)
- Power required to move the plate with the velocity V:
  - $P = \frac{\mathrm{d}E}{\mathrm{d}t} = F \frac{L}{t} = F \, V$ (power = energy / time)