# Benchmark

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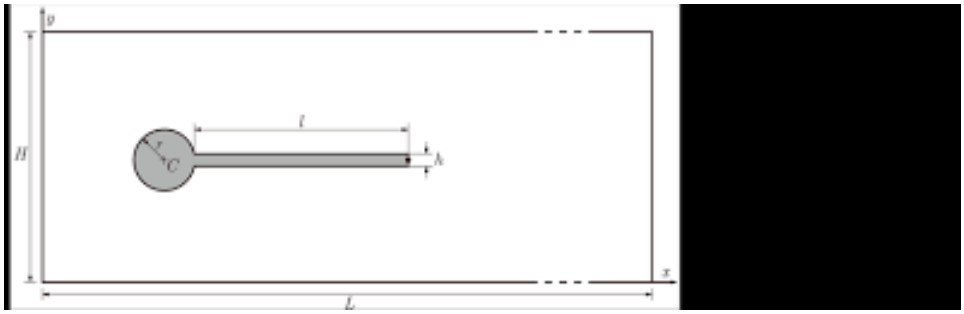
# Problem Defintion

## Domain




The computational domain resembles the classic cfd benchmark with an added bar, with dimensions:
The box: L = 2.5, H = 0.41
The bar: l = 0.35, h = 0.02
s The circle is positioned at (0.2, 0.2) making it 0.05 of center from bottom to top, this is done to induce oscillations to an otherwise laminar flow.
Boundary conditions:
The fluid velocity has a parabolic profile on the inlet that changes over time:

$$u(0,y) = 1.5u_0 \frac{y(H-y)}{(\frac{H}{2})^2}$$

$$u(0,y,t) = u(0,y)\frac{1-cos(\frac{\pi}{2}t)}{2} \text{ for } t < 2.0$$

$$u(0,y,t) = u(0,y) \text{ for } t \leq 2.0$$

We set no slip on the floor"and "ceilingso to speak.
On the fluid solid interface the boundary conditions are set to:

$$\sigma_f n_f = \sigma_s n_s \quad on \ \ \Gamma^0(interface)$$

In our variational form we leave this out and so implying that they are equal.

## CSM test

Parameters

Tabell 1: My caption

| Parameters | CSM1 | CSM2 | CSM3 |
|---|---|---|---|
| $\rho_f[10^3 \frac{kg}{m^3}]$ | 1 | 1 | 1 |
| $\nu_f[10^{-3} \frac{m^2}{s}]$ | 1 | 1 | 1 |
| $u_0$ | 0 | 0 | 0 |
| $\rho_s[10^3 \frac{kg}{m^3}]$ | 1 | 1 | 1 |
| $\nu_s$ | 0.4 | 0.4 | 0.4 |
| $\mu_s[10^6 \frac{m^2}{s}]$ | 0.5 | 2.0 | 0.5 |
| $g$ | 2 | 2 | 2 |

## FSI test

Tabell 2: My caption

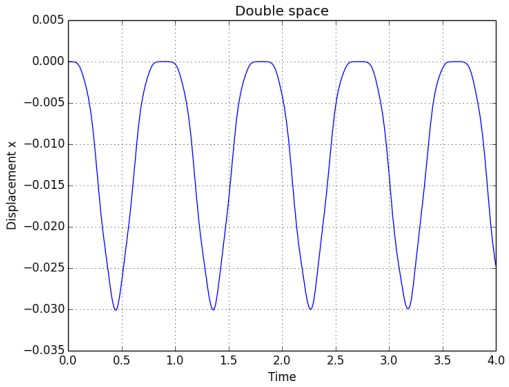
| Parameters | FSI1 | FSI2 | FSI3 |
|---|---|---|---|
| $\rho_f[10^3 \frac{kg}{m^3}]$ | 1 | 1 | 1 |
| $\nu_f[10^{-3} \frac{m^2}{s}]$ | 1 | 1 | 1 |
| $u_0$ | 0.2 | 1 | 2 |
| $\mathrm{Re} = \frac{Ud}{\nu_f}$ | 20 | 100 | 200 |
| $\rho_s[10^3 \frac{kg}{m^3}]$ | 1 | 10 | 1 |
| $\nu_s$ | 0.4 | 0.4 | 0.4 |
| $\mu_s[10^6 \frac{m^2}{s}]$ | 0.5 | 0.5 | 2 |

Results:

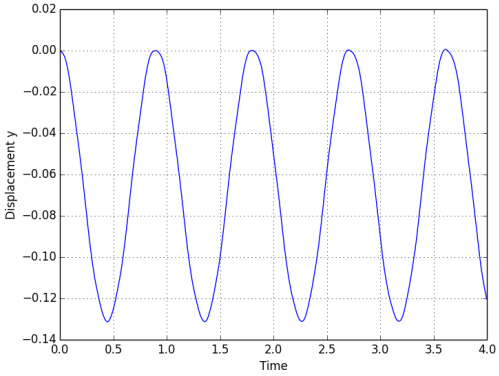
Tabell 3: My caption

| Cells | Dofs | ux of A $[\times 10^{-3}]$ | uy of A $[\times 10^{-3}]$ | Drag | Lift | Spaces |
|---|---|---|---|---|---|---|
| 2698 | 7095 | 0.0213214 | 1.01342 | 14.1679 | 0.942656 | P1-P1-P1 |
| 2698 | 23563 | 0.02271 | 0.80288 | 14.1736 | 0.787891 | P2-P2-P1 |
| 10792 | 92992 | 0.0227341 | 0.808792 | 14.1855 | 0.801044 | P2-P2-P1 |
| 43168 | 369448 | 0.227352 | 0.812595 | 14.227 | 0.797242 | P2-P2-P1 |
| **ref** | **ref** | **0.0227** | **0.8209** | **14.295** | **0.7638** | **ref** |

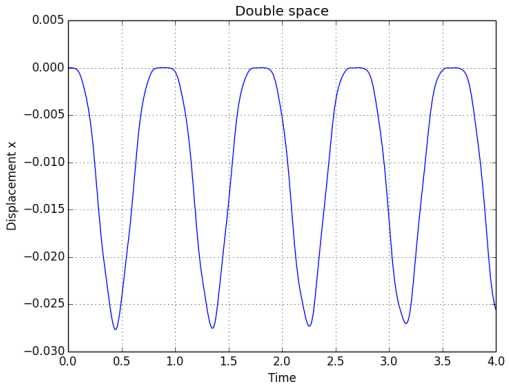
@articlequaini2014extended, title=An extended ALE method for fluid-structure interaction problems with large structural displacements, author=Quaini S ?Canic, S Basting A and Glowinski, R, year=2014



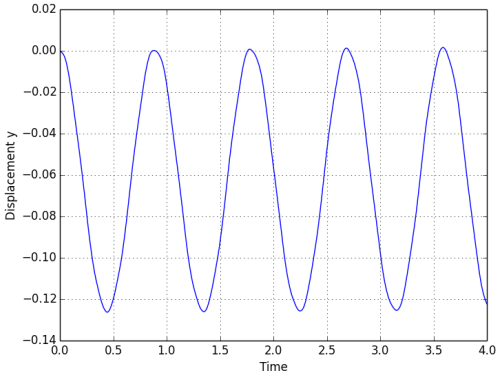

Figur 1: diff x with diffusion term




Figur 2: diff y with diffusion term




Figur 3: diff x without diffusion term




Figur 4: diff y without diffusion term