Lab 8: 03/31/04
Incompressible Inviscid Flow

1. Figure 1 shows a boat travelling at velocity $\mathbf{v}_0$ within a river section Ω with dimensions L and H. The boat is modelled with two splines that can be described by the parameters ℓ and h.

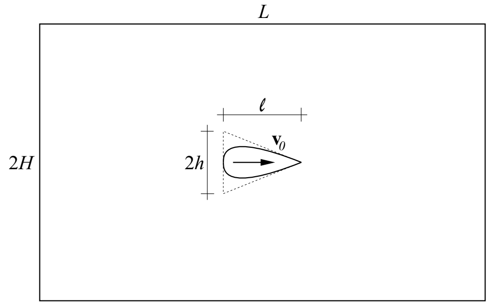

Figure 1: Boat in a River

2. Incompressible inviscid flow is governed by the same PDE as stationary heat transfer. Use the heat equation to model the problem in femlab. Model it such that you can easily change the geometry parameters above. Make use of symmetry.

3. The hydrodynamic mass is defined as

$$M_{hydro} = \frac{T}{\frac{1}{2}\mathbf{v}_0 \cdot \mathbf{v}_0} \quad , \tag{1}$$

with the kinetic energy

$$T = \int_\Omega \frac{1}{2}\rho\, (\mathbf{v} - \mathbf{v}_0) \cdot (\mathbf{v} - \mathbf{v}_0)\, dA \quad . \tag{2}$$

Derive an expression for M_{hydro}/M_{displ}, i.e the hydrodynamic mass per displaced water mass. Does the resulting expression depend on the magnitude of $\mathbf{v}_0$? Compute M_{hydro}/M_{displ} using the femlab integration command *postint* to integrate across Ω.

4. Let $\ell = 20m$, $L = 100m$ and $H = 50m$. Plot M_{hydro}/M_{displ} as a function of h between $h = 2m$ and $h = 20m$.

5. Change the river width to $H = 20m$ and repeat item 4.