Homework #1 **Deadline: March 4, 2020, 9:00.**

1. The Navier-Stokes equations are obtained by inserting the constitutive equations for the Navier-Stokes fluids (compressible, incompressible non-homogeneous, incompressible homogeneous) into the balance equations for mass and linear momentum. Perform this operation for all three cases and distinguish the situations μ, λ are depending on ϱ or being constant, simplify whenever possible.

2. Show that if $\mathbf{v}$ is smooth enough, $\operatorname{div} \mathbf{v} = 0$ in Ω and $\mathbf{v} = \mathbf{0}$ on $\partial\Omega$ then the following identity holds
$$2\|\mathbf{D}(\mathbf{v})\|_2^2 = \|\nabla \mathbf{v}\|_2^2,$$
where $\mathbf{D}(\mathbf{v}) = (\nabla \mathbf{v} + (\nabla \mathbf{v})^{\mathrm{T}})/2$.

3. The following table shows the typical values of the viscosities in the units cP.

Fluid	Viscosity [cP]
air (18 °C)	0.02638
gasoline	0.5
water (18 °C)	1
milk	3
olive oil	84
motor oil SAE50	540
honey	2 000 – 3 000
ketchup	50 000 – 70 000
peanut butter	150 000 – 250 000
asphalt / tar	3×10^{10}
Earth lower mantel	3×10^{25}.

What is cP? Is it a unit of kinematic or dynamic viscosity? How is it related to a standard unit? After who is the unit named? Write three pieces of information about this scientist.