MATHEMATISCHES INSTITUT

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NAME: _____

MAT-NR.: _____

Introduction to Computational Fluid Dynamics – 2. Übungsblatt

Aufgabe 5: Consider the following velocities of two different flows:

$$\mathbf{u}_1 = x\mathbf{i} - y\mathbf{j} + 2z\mathbf{k}, \qquad \mathbf{u}_2 = x\mathbf{i} + (t - y)\mathbf{j}.$$

Classify the flows as steady/unsteady, whether it is $1D-$, $2D-$, or $3D-$flow, and whether it has a stagnation point.

Aufgabe 6: A fluid moves with velocity field

$$\mathbf{u} = (2x + y)\mathbf{i} + (ay + 2yz)\mathbf{j} + bz^2\mathbf{k}.$$

(a) Determine a and b such that the flow is incompressible.

(b) What is the vorticity of the flow for general a and b? When is the flow irrotational?

Aufgabe 7: The material derivative of the density, ρ, of a fluid motion is given by

$$\frac{D\rho}{Dt} = \frac{\partial \rho}{\partial t} + (\mathbf{u} \cdot \nabla)\rho.$$

(a) What value does $\frac{D\rho}{Dt}$ for an incompressible flow?

(b) Determine $\frac{D\rho}{Dt}$. for the following velocities and densities:

  (a) $\mathbf{u} = (1, 2, -1)^T$, and $\rho = x + y + z$.
  (b) $\mathbf{u} = (1, 0, 0)^T$, and $\rho = z$.

(c) State whether the flows are incompressible or compressible.

Aufgabe 8: A particle is carried in a flow field with velocity field

$$\mathbf{u} = 8x\mathbf{i} + t\mathbf{j} - 6y\mathbf{k}.$$

By evaluating the 12 terms of the material derivative vector $\frac{D\mathbf{u}}{Dt}$, determine the acceleration of a fluid particle which at time $t = 1$ is passing through the point $(1, 1, 0)$. If the particle is moving through the temperature field $T = z$, calculate the rate of change of the particle's temperature as is moves with the flow when it is at a general point (x, y, z).

Abgabe am 23. April 2018 am Beginn der Vorlesung.

Besprechung in der Übung am 30. April 2018.