Constants

- Normdruck: $p_{ref} = 1atm = 1.01325\,bar$
- Normtemperatur: $T_{ref} = 298\ K \approx 25°\ C$
- Pferdestärke: $1\ hp = 1\ PS = 0.735\ kW$
- Elementarladung: $e = 1.60219 \cdot 10^{-19}\ C$
- Faraday-Konstante: $F = N_A \cdot e = 96485.3 \frac{C}{mol} = \frac{A \cdot s}{mol}$
- ppm = parts per million: $1\ ppm = 10^{-6}$
- Gaskonstante: $\overline{R} = 8.314 \frac{J}{molK}$, spez. – $R = \frac{\overline{R}}{M} [\frac{J}{kgK}]$

Parameters

- Aerodynamic Force F_A
- Aerodynamic Moment M_A
- Lift Coefficient $C_l = L/(1/2\rho V^2 c)$
- Drag Coefficient $C_d = D/(1/2\rho V^2 c)$
- Moment Coefficient $C_m = M_A/(1/2\rho V^2 c^2)$
- Angle of Attack α angle between connection leading and the trailing edge and reference line
- Lift curve slope $a = C_l/\alpha$

Steady Aerofoil and Wing Section Aerodynamics

- Aerofoil = 2-D wing section with goal to generate lift force perpendicular to the relative airspeed
- Convention: Lift is up, Drag is in direction of windspeed and Aerodynamic moment in clockwise direction acting on the aerodynamic center. Aerodynamic center is normally at the quarter chord position $c_{m,c/4}$ for syymetric airfoils. $x_{ac} = -m_0/2\pi + 0.25$ with m_0 as a shape constant
- Further assumptions: No viscosity, incompressible fluid, $Ma < 0.2, 0.3$, no vortices, potential flow (Navier-Stokes)
- Another centre is the shear center (elastic axis) from mechanics
- $L = 1/2\rho V^2 ca\alpha$, with a from tables (CFD and Wind Tunnel)
- $M_a = 1/2\rho V^2 c^2 c_{m\phi}$ with $c_{m\phi}$ also from tables

Lift curve $C_l(\alpha)$ and drag curve $C_d(\alpha)$

- At small ranges of α, both lift and drag increase with: $C_l \propto \alpha$ and $C_d \propto \alpha^2$
- In aeroelasticity and this course, α will be very small, hence drag will be negligble small

The aerodynamic moment M_A

- The aerodynamic moment is much more important than drag C_d
- M_A varies with α in the small ranges of the angle of attack
- **Important to note:** There exist a point at which the aerodynamic moment does not depend on α. This is the the aerodynamic centre
- The aerodynamic centre is not the same as the centre of pressure, which is defined as the point where the aerodynamic moment is zero given a certain angle of attack α
- Symmetric airfoils at $\alpha = 0$ have no aerodynamic moment at all times ($M_A = 0 = const$). At the aerodynamic centre for symmetric foils results into no moment
- Asymmetric airfoils at $\alpha = 0$ have a non-zero aerodynamic moment at all times (all angles α)

Assessment of C_l/α

-