Task 4.7

a) $Y = \cancel{u_1 v_{1t}}^{\,v_{1t}=0} - u_2 v_{2t}$

$\underline{v}_1$ in radial direction only $\Rightarrow$ $\underline{v}_{1t} = 0$

u_2 from spinning

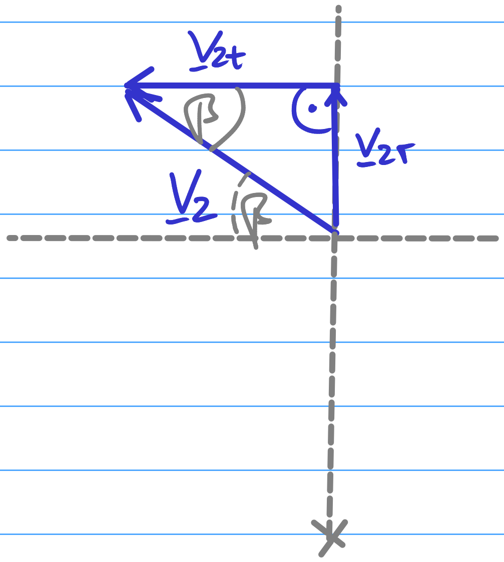
$u_2 = r_2 \cdot \omega$

angular velocity ... from rpm

$= 0.15\,\mathrm{m} \quad \underbrace{3000 \frac{2\pi}{60\,\mathrm{s}}}_{3000\ \mathrm{rpm}\ =\ \text{rounds per minute}}$

$= 47.12\ \mathrm{m/s}$

v_{2t} from triangle



$v_{2t} = v_2 \cos\beta$

$= 42{,}29\ \mathrm{m/s}$

$\Rightarrow Y = -\ 47.12\ \mathrm{m/s} \times 42{,}29\ \mathrm{m/s}$

$= -1992{,}69\ \frac{\mathrm{m}^2}{\mathrm{s}^2}$

Task 4.7

b) $P = \dot{m} \cdot Y = \rho \dot{V} Y$

$= 1000 \frac{kg}{m^3} 60 \frac{l}{s} \cdot Y$

$= \cancel{1000} \frac{kg}{\cancel{m^3}} 60 \frac{\frac{1}{\cancel{1000}} \cancel{m^3}}{s} \cdot (-1992,69 \frac{m^2}{s^2})$

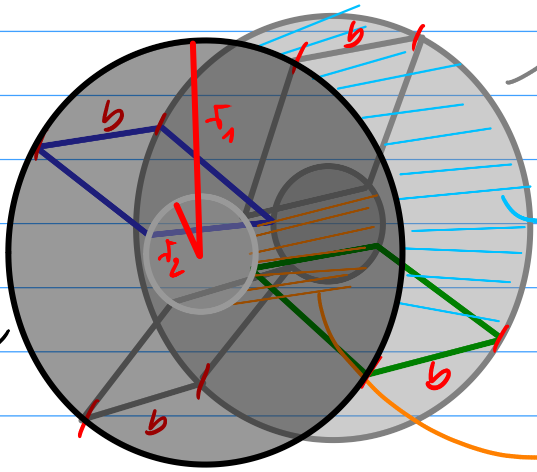
$\frac{kg \frac{m^2}{s^2}}{s} = W$ ✓

$= -119561 \; W$

$= -119.6 \; kW$

Task 4.8
(Turbine)

rear
(hinten)



front
(vorne)

outer cylinder mantle
(Mantelfläche außen)
$A_1 = 2\pi r_1 \cdot b$

inner cylinder mantle
(Mantelfläche innen)
$A_2 = 2\pi r_2 \cdot b$

continuity equation: $\dot{V}_1 = \dot{V}_2$
(Kontinuitätsglg.)

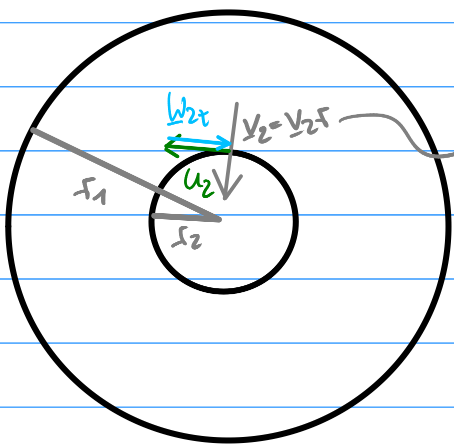
$$A_1 v_{1r} = A_2 v_{2r}$$

(Maßzahlen, Beträge)

only radial components contribute as only they contribute to „pass through"

nur die radialen Komponenten, denn nur die „gehen durch"!

$\Rightarrow$ Link between inner and outer velocities



„rein radial" oder „ideal" $\Big\}$ $\underline{v}_t = 0$

$$\underline{v}_t = \underline{u} + \underline{w}_t$$

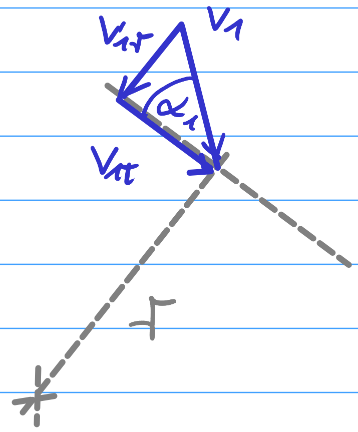
$$\Rightarrow 0 = \underline{u} + \underline{w}_t$$

$$\Rightarrow \underline{w}_t = -\underline{u}$$

Task 4.8

a) $u_1 = ?$ no information given about rotation .... except Y-value!

$$Y = \underset{?}{u_1} V_{1t} - \overset{0 \text{ as in text}}{\cancel{u_2 V_{2t}}}$$



$$\Rightarrow \quad u_1 = Y / V_{1t}$$

$$= \frac{Y}{V_1 \cos \alpha_1}$$

b) $\beta_1 = ?$ $\quad \tan \beta_1 = \dfrac{W_{1r}}{W_{1t}}$

$$W_{1r} = V_{1r} = V_1 \sin 20° = \ldots .$$

$$V_{1t} = W_{1t} + u \Rightarrow W_{1t} = V_{1t} - \underset{\text{from a)}}{u_1} = \ldots .$$

Task 4.8c)

$$w_{2r} = v_{2r}$$

$$A_1 v_{1r} = A_2 v_{2r}$$

$$v_{1r} = v_1 \sin \alpha_1$$

$$A_1 = 2\pi r_1 \cdot b$$

$$A_2 = 2\pi r_2 \cdot b$$

$$\Rightarrow w_{2r} = v_{2r} = \frac{A_1}{A_2} v_{1r} = \frac{\cancel{2\pi} r_1 \cdot \cancel{b}}{\cancel{2\pi} r_2 \cdot \cancel{b}} v_{1r}$$

d) Outflow angle β_2 ? $\tan \beta_2 = \dfrac{w_{2r}}{w_{2t}}$

from c)

?

$$v_{2t} = u_2 + w_{2t}$$

0 because outflow purely radial

$$\Rightarrow w_{2t} = -u_2 \qquad \Rightarrow \text{what is } u_2?$$

$$u_1 = \omega \cdot r_1 \Rightarrow \omega = \frac{u_1}{r_1} = \frac{u_2}{r_2}$$

$$\Rightarrow u_2 = \omega \cdot r_2 = \frac{r_2}{r_1} u_1 = \ldots = -w_{2t}$$

$$\Rightarrow \beta_2 = \arctan\left(\frac{w_{2r}}{w_{2t}}\right) = \ldots$$

cf. spreadsheet.
up to a sign...