

## Unsteady BEM for VAWT

This exercise deals with a Vertical Axis Wind Turbine, VAWT and how to estimate the time dependent loads using an unsteady BEM approach, **as described in the lecture notes.**

$R=3\text{m}$ ,  $V_o=8\text{m/s}$ ,  $\omega=12\text{ rad/s}$ ,  $B=2$ ,  $\rho=1.225\text{ kg/m}^3$ ,  $\theta_p=0$ ,  $S=B\cdot c/R=0.2$ . The airfoil data are given in the file airfoil.txt.

Q#1: Compute and plot as function of time  $p_{t,B=1}$ ,  $p_{x,\text{tot}}$ ,  $p_{y,\text{tot}}$ ,  $C_T$  and  $C_p$ . Wait until the solution becomes periodic and estimate the time averaged  $C_T$  and  $C_p$

$p_{x,\text{tot}}(t)$  and  $p_{y,\text{tot}}(t)$  are the sum of the loads from all blades at time,  $t$ , in  $x$  and  $y$  direction, respectively and is the load felt by the tower.

$p_{t,B=1}(t)$  is the tangential load experienced by only blade #1.

Q#2: Now add one blade so  $B=3$ , but keep the solidity at  $S=0.2$ . Plot  $p_{x,\text{tot}}$ ,  $p_{y,\text{tot}}$  and explain the difference in the loads experienced by the tower. Compare the time averaged  $C_T$  and  $C_p$  with the 2 bladed VAWT having the same solidity.