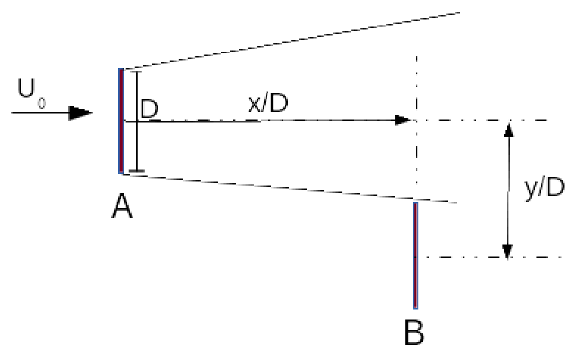
AME 40530 Wind Turbine Performance, Control and Design

Spring, 2016

Homework No. 3

Problem 1. Consider a pair of wind turbines, each with rotor radii of $r_r = 20\,\text{m.}$, hub heights of $z = 60\,\text{m}$. At the site the roughness height is $z_0 = 0.3\,\text{m}$.
For both wind turbines, the design torque coefficient is $C_T = 0.88$. The free-stream wind speed is $U_\infty = 12\,\text{m/s}$.



1. For this system, based on the Jenson (1983) analytical wake model described in the chapter on wind farms, determine the spanwise distance, y/D of the downwind turbine (B) so that it is **not affected** by the wake of the upstream turbine (A) for positions of Turbine B of $x/D = 4$, 7 and 10.
2. Repeat Part 1 with $C_T = 0.80$ for Turbine A.
3. How did this lowering of the design torque coefficient affect the energy density (power-per-square-area) of the wind farm?

Problem 2. A community wishes to replace an existing wind turbine with another with a higher rated power. The original wind turbine had a sound pressure level in the audible range measured at the hub height of 100dB. The new higher powered wind turbine has a sound pressure level that is 10dB higher. The hub height for both wind turbines is 50 ft.

Assuming an atmospheric absorption of $\alpha = 0.005$, perform the following.

a. For the **original wind turbine**, plot the sound pressure level as a function of the ground distance for up to 1000 ft. from the base of the wind turbine.

b. Plot the sound pressure level as a function of the ground distance from the base of the wind turbine for the **new wind turbine**.

c. How much further from the new wind turbine compared to the old turbine, must homes be to meet the Suburban night time sound level restriction of 30dB?