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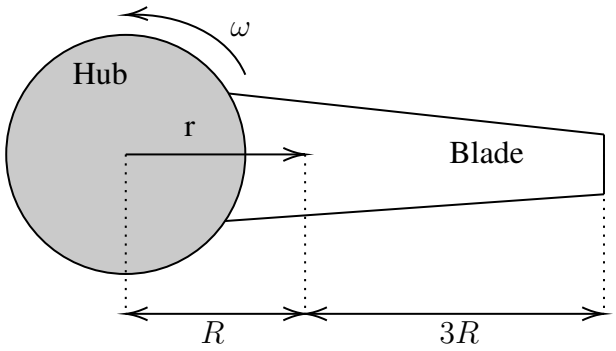
Aerospace 523: Computational Fluid Dynamics
Homework: XX
Due: September 6th, 2020

1 Aircraft Propeller

An aircraft's propeller consists of a rigid hub of radius R and a flexible tapered blade of length $3R$ that has density $\rho(kg/m^3)$. The propeller is rotating about the center of the hub with a steady angular velocity ω, thereby creating an effective axial distributed force in the blade. Neglect forces due to gravity. The cross sectional area distribution of the blade is $A(r)$, defined as

$$A = -A_L \left(\frac{r}{R} - 5\right), \quad \text{if } R < r < 4R$$



a. Write down the expression for body force due to rotational acceleration.

b. In the 1D equilibrium equation derived in class, the area of cross section was constant. Show that the 1D equilibrium equation for the case of a changing cross sectional area is $\frac{d}{dr}(\sigma A) + fA = 0$.

c. Write down the boundary conditions for the problem.

d. Find the axial stress distribution, $\sigma(r)$