Comments:
Progress Report #1
Design Project

Report 02 is due on Thursday, February 11th

Tasks to accomplish:

- From Report 01:
  - Update report. See these notes + Notes in your Report 01
  - State “objectives” of the project
  - Update background research/data on: typical dimensions of the machine of interest. Specifically of the two components under consideration
  - Specify characteristics of the specific components of interest: dimensions, geometries, design configurations, materials used, etc. You need these for future analyses
- Determination of applied loads
- FBDs: overall and for each component of interest; include parametric calculations for $q(x)$, $V(x)$, $M(x)$, $\theta(x)$, and $\delta(x)$
- Identification of “Critical Sections and Points” - w/stress cubes
- Stress analysis - principal normal stress/Mohr’s circles

There’s no limit on the length of your report, but... be brief and to the point... MEMO format.
Design project for this course
Cutaway of a typical wind turbine with blade pitch control

Vestas’ turbine: V52-850 kW

<table>
<thead>
<tr>
<th>Weight (IEC I/IEC II A)</th>
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</thead>
<tbody>
<tr>
<td>Hub height: 60 m 67 m 78 m</td>
</tr>
<tr>
<td>Tower: 140 t/124 t 158 t/142 t 203 t/199 t</td>
</tr>
<tr>
<td>Nacelle: 61 t 61 t 61 t</td>
</tr>
<tr>
<td>Rotor: 37 t 37 t 37 t</td>
</tr>
<tr>
<td>Total : 238 t/222 t 256 t/240 t 301 t/297 t</td>
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</table>
Design Project: FBD and general considerations
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You need to define (and analyze) overall FBD first

Definition of FBD's for individual components depends on mechanical configuration chosen

Some initial dimensions are “fixed”. Others are to be determined
Design Project: FBD and general considerations

This is only a recommended diagram

What is the “tip-speed” ratio for this machine? What is “tip-speed” ratio? Do we need this ratio?

Consider:
- \( V_{wind} : [5, 25] \text{ m/s} \Rightarrow \text{Need: tip-speed ratio (to determine angular speed of rotation).} \)
- \( \text{Loading: wind pressure} \Rightarrow \text{Bending} \Rightarrow \text{Torque: T} \)
- \( \text{Include: weight of} \)
  - Blades,
  - Hub,
  - Nacelle
  - Tower,
  - Wind pressure on tower (linear/parabolic/other distribution)?
- \( \text{Tower: variable cross-section to minimize weight} \)
- \( \text{Recall:} \)
  - (a) Power = (output torque) \cdot (angular speed)
  - (b) Conservation of energy: \( \frac{1}{2} pV^2 + P = \text{constant} \)
  - (c) Consider Betz's criterion to include efficiency of machine.
  - (d) Power = \( (\text{Torque}) \cdot (\text{Angular Velocity}) \)