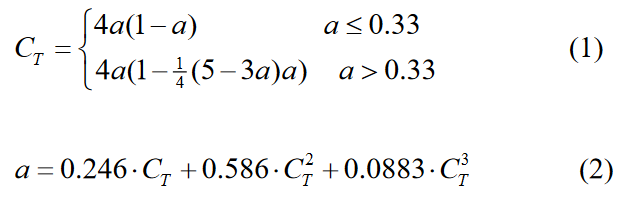
# Assignment 1 Plan

## Q1

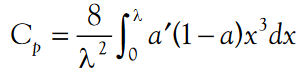
* Task:

Compute the highest obtainable power coefficient, , and the corresponding values of the tip speed ratio and pitch angle, and . Try both equation (1) and (2) for momentum equation and compare the two solutions. Make and discuss the contour plots and .



Tip: The optimum pitch lies between -4 and 3 degrees and the optimum tip speed ratio between 5 and 10.

* Approach:
* Implement BEM based on &
* Implement iterative BEM solver
* Implement as a function of (cf. Eq. 4.30)

 or rather

* Implement Integrator of
* Find maximum of that integration. Possible approaches

1. Calculate for an array of all possible .combinations within the boundaries from the task description (with an appropriate step width)
2. Use an optimization function to solve for the best (e.g. scipy.optimize.minimize with )

* Additional Tasks
* Plot and and discuss the plots

## Q2 &

* Task:

Imagine that we want the turbine to run at the maximum all the way to rated power . What is the rated wind speed, and the maximum rotational speed needed, . Also plot .

* Approach:

Implement a function to calculate using the integrator for from Q1

1. Calculate using the integrator for from Q1 inside a while loop until is reached

Idea: Start at first calculate for decreasing wind speeds. If this doesn’t yield the desired result, then calculate for increasing wind speeds

1. Use an optimization to solve for the best (e.g. scipy.optimize.minimize with (Question: This function is not continuously differentiable. Will this lead to problems?)

* Additional tasks:

plot (that’s just a line)

## Q3 for

* Task:

To limit the power at high wind speeds one can pitch the blades. Compute and plot the pitch setting, between cut-in and cut-out wind speed when the mechanical power is limited to 10.64 MW and the rotational speed to .

Compare your result with the report describing the DTU 10MW WT. Plot and comment as function of the wind speed the power, , and thrust, and their corresponding non-dimensional coefficients and .

* Approach:

Use an optimization to solve for using the integrator for for a range wind speeds above . The pitch angle can then be computed from the angle , resulting from the values for .

* Additional tasks:
* Compare your result with the report describing the DTU 10MW WT
* Plot and comment as function of the wind speed the power, , and thrust, and their corresponding non-dimensional coefficients and
* Implement a function to calculate & (c.f. Eq. 6.12 & 6.13)
* Implement a function to integrate the Thrust & Moment (cf. Eq. 6.21 & 6.22)

## Q4 Comparison of Ashes and aerodynamic loads of BEM

* Task:

Run the Ashes program and compare the aerodynamic loads with your own BEM code for . Try and explain the source of any differences you may see.

* Approach:

## Q5 AEP for &

* Task:

Compute the annual energy production for the pitch regulated wind turbine erected at a site with following Weibull parameters, and . How much energy is lost if the wind turbine is stopped at instead of , and why could that in some cases be a good idea.

* Approach:
* Implement a function to calculate the Weibull probability for a wind speed being in a specific range (cf. Eq. 6.48)
* Implement a function to calculate the AEP based on a wind velocity range (cf. Eq. 6.49)

This function is based on the previous calculations for the parameters of the power coefficient depending on the wind speed. For , the power curve based on is used and for ,

* Calculate this function for &

## Q6 & for maximum at for

* Task:

Try and find the chord and angle with the rotor plane that will maximize the local at using a tip speed ration . The optimum chord value is between 0 and 3 m.

* Approach:

See last 2 slides of BEM lecture

1. Maybe Use Eq. 4.38 (This however does not take the Prandtl or Gaulert corrections into account) to determine

* Determine from using eq. 6.7
* Reverse calculate the BEM based on the now known value for (interpolation needed) – seems too elaborate