Assignment #2:

This assignment is about using the unsteady BEM code to simulate a PI collective pitch controller.

Q#1

Assume that the operational condition yielding the highest Cp of the DTU 10 MW reference wind turbine is λ=8 and θ_p=0°.

- Determine the optimum generator characteristic, $M_G(\omega)$that would ensure this.

Neglect any constraint of the rotational speed and assume a constant torque after rated power P=10.64MW is reached.

Use the standard atmospheric density ρ=1.225 kg/m3

Now implement a PI controller in the unsteady BEM code and compute dynamically the rotational speed as:

$$I\frac{d\omega}{dt} = M_{aero}(V_o, \theta_{p,}\omega) - M_G(\omega)$$

The inertia moment of the drivetrain is I=1.6·10^8 kgm^2.

The gains for this operation are:

KI=0.64 rad/rad
KP=1.5 rad/(rad/s)
KK=14 deg.
The pitch angle is limited between 0 and 45 degrees.

Remember that the rotational speed is no longer constant, so the relative wind becomes:

$$\begin{pmatrix} V_{rel,y} \\ V_{rel,z} \end{pmatrix} = \begin{pmatrix} V_{o,y} \\ V_{o,z} \end{pmatrix} + \begin{pmatrix} W_y \\ W_z \end{pmatrix} + \begin{pmatrix} -\omega(t)\cdot r \\ 0 \end{pmatrix}$$

Q#2

Show that the steady result for a constant wind of 9 m/s (below rated) ends in λ=8 and θ_p=0° corresponding to maximum Cp as assumed in Q1. Then use this code to determine the necessary pitch angles $\theta_p(V_0)$ to obtain the rated power of 10.64 MW above rated wind speed.

Q#3

Simulate and report results including turbulent wind.

Q#4

Run some of the Q#2 cases (both below and above rated) in ASHES:
-1) Using the DTU Controller (default in the DTU10MW setup).
-2) By exchanging the DTU controller with a PID controller with the same settings (e.g. gains) as your code.
Compare and comment on the differences you see if any.