Small exercise on torque control for a stall controlled WT

This is a small exercise that models the rotational speed during start up and running in a turbulent wind for a wind turbine with fixed pitch (stall regulated)

Instead of the BEM code just assume that you can simply use a Cp-λ curve for constant pitch angle.

Values for $C_p(\lambda)$ are uploaded in the file Cp-Lambda.txt
In the file usim.dat is given a turbulent wind history

The rotor radius is R=9.5m, the density ρ=1.225kg/m^3. For a given ω the aerodynamic torque can be computed as $M_R = P/\omega = \frac{1}{2}\rho V_o^3 \pi R^2 C_p(\lambda)/\omega$

An asynchronous generator is assumed having following characteristics

$$M_G(\omega) = \begin{cases} 0 \text{ Nm} & \omega < 5 \text{ rad/s} \\ 2.55 \cdot 10^5 (\omega - 5) & \omega > 5 \text{ rad/s} \end{cases}$$

The equation determining the rotational speed as function of time is

$$I \frac{d\omega}{dt} = M_R - M_G$$

Where I=15000 kgm^2 is the moment of inertia for the drive train (mainly the blades)

1) Plot Cp(λ)
2) Plot Vo(t) (turbulent wind)
3) Discuss how to solve numerically ω(t)
4) Calculate ω(t), M_R(t) and M_G(t) for an initial angular velocity of ω(0)=1 rad/s for V_o=10m/s.
5) Calculate the slip SL
6) Repeat Q#4, but now using the turbulent inflow wind speed, V_o(t) caused by atmospheric turbulence. Compare and discuss V_o(t) and ω(t)
7) Simulate a free running turbine for V_o=const=10m/s and ω(0)=1