Design of Wind Energy Systems – Summer Semester 2016
CIP-Tutorial 6a: Fatigue & Extreme loads

Tasks to be solved in Tutorial 6:

1. In CIP-Tutorial 5, wind fields were created for wind speeds 5, 10, 15, 25 m/s (task 4) using wind class I-B. Run simulations with FAST for these wind conditions.

   Hint: To understand the impact of turbulence intensity, we will use these conditions as free stream. To speed-up multiple calculations edit file: FAST_batchmode.bat

2. Plot the bending moments for your tower (side-to-side and fore-aft) and for the blade at its root (edgewise and flapwise bending moment) under free stream conditions

   Hint: Use the Matlab script PlotFastTimeseries.m included in the folder. The name of the variables and its physical meaning are included at the bottom of FAST input file

3. Calculate the damage equivalent loads (DEL) for your tower (side-to-side and for-aft) and for the blade at its root (edgewise and flapwise bending moment)

   Hint: DELs are representative for the fatigue damage of a certain time series. Matlab script PlotFastTimeseries.m places results in workspace

4. In CIP-Tutorial 5, wind fields were also created for the analysis of wake conditions (task 5), using the Frandsen model to account for the effective turbulence due to the presence of neighboring turbines at 4 and 8 diameters of distance. Simulate with FAST also for these wake conditions.

   Hint: Pay attention to the Whöler exponent (m) used in each analysis. To understand the impact of wake conditions and neighboring turbines, we will use these wind fields

5. Calculate the damage equivalent loads for your tower (side-to-side and fore-aft) and for the blade at its root (edgewise and flapwise bending moment), under wake conditions.

6. Compare the damage equivalent loads calculated for free stream and wake conditions (with neighboring turbines at 4 and 8 diameters distance).

7. Estimate the statistical max/min values of the sensors analyzed above under each of the scenarios and report them in a table. Comment the results.

   Hint: PlotFastTimeseries.m places all values in workspace using a fixed name, update script or rename loaded values to avoid deleting previous results

8. Evaluate the power spectral density of two load timeseries (for example blade root out of plane bending moment and tower base fore-aft bending moment) and comment the plots with respect to the eigenfrequencies of the system. Choose two wind speeds for a better description.

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Hint: Uncomment and update “power spectrum density” section in Matlab script PlotFastTimeseries.m to evaluate various sensors