# Design of wind energy systems – Summer Term 2016
# Tutorial 5: Load analysis and component design

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| Date of issue: 06.2016<br>Submission deadline: | | |

The following task is related to CIP-Tutorial 5 & CIP-Tutorial 6. Use the simulated load time series which have been generated during those tutorials to perform the tasks.

a) Perform a Rainflow Counting (RFC) and calculate load spectra

- Plot the load spectra from the individual 10 min. time series: 1st set of plots: M_flap, M_edge, Fx_ttop for 15 m/s
- Calculate the static edgewise blade root bending moment M_edge & number of revolutions during the 10 min time series
- Calculate the damage equivalent loads (DELs) of sensors M_flap, M_edge, Fx_ttop and My_tbase for free flow and the two wake conditions and discuss the results

b) Load extrapolation to 20 years

- Extrapolate the load spectra from the individual 10 min. time series to 20 years operation.
- Plot the 20 yrs load spectra of My_tbase for free flow and the two wake conditions in one diagram and discuss the results
- Calculate the DEL for My_tbase and compare the result with the following expression. Where $h_i$ is the hour ratio for each wind speed bin

$$DEL = \frac{\sqrt[4]{DEL\left(M_{y_{tbase}@5m/s}\right)^4 h_1 + DEL\left(M_{y_{tbase}@15m/s}\right)^4 * h_2}}{h_1 + h_2}$$

c) Fatigue strength calculation at tower base

Calculate the section modulus at the tower base W (m^3)
Determine the stress ranges at tower base

$$Delt\,a_{sigma} = \frac{M_{y_{tbase}}}{W}$$

Hints:

- S-N curve (m=4), detail category 71 MPa (fillet weld at door section)
- Damage calculation with Palmgren-Miner hypothesis
- Damage, lifetime = 20 years / D