Fluid Dynamics + Turbulence (fall 2017)
Homework Problems I

Posted: Friday September 01, 2017.

Deadline for submission of homework problem:
Tuesday September 12 at 01.15 pm (on paper in Navitas 04-041).

1 Homework problem 1.1: Modeling and optimisation of a one-dimensional wind farm

Read the paper J. Herp et.al.: *Wind-farm power optimisation including flow variability*, Renewable Energy 81 (2015) 173-81, and learn about the Jensen wake model with the Katic wake superposition and the sequential optimisation.

(a) Implement the Jensen wake model with Katic superposition for a one-dimensional wind farm with N turbines, equidistant turbine spacing Δx and aligned wind direction.

(b) Determine the turbine powers P_i for the Betz induction factors $q_i = 1/3$ ($1 \leq i \leq N = 10$). Use $u_0 = 10\text{m/sec}$, $\Delta x = 12R$ and $k = 0.04$. Produce a figure showing your results.

(c) Implement the sequential optimisation, and determine the optimised induction factors q_i^{sopt} and turbine powers P_i ($1 \leq i \leq N = 10$). Produce figures showing your results.

(d) Apply a standard MATLAB optimisation routine, and determine the optimised induction factors q_i^{opt} and turbine powers P_i ($1 \leq i \leq N = 10$). Produce figures showing your results.

(e) Compare your results from (d) with those from (b) and (c).

(f) Discuss the solutions q_i, P_i as a function of $N = 5/10/20$ and $k\Delta x/R$ with e.g. $k = 0.02/0.04/0.07$ and/or $\Delta x/R = 8/12/16$.