Assignment A - unsteady BEM with dynamic inflow model

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Group 4

Instructions

Do this group assignment in groups of 3. You can make the groups yourself and/or use the Discussion board to find a group. This assignment counts for 40% of your grade.

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Overview

In this assignment you are asked to modify the BEM (Blade Element Momentum) model developed in the course AE4135 Rotor-wake aerodynamics to include dynamic inflow.

The dynamic inflow should include the Glauert correction for heavily loaded rotors for the wind turbine case. Implement the Pitt-Peters, Oye and Larsen-Madsen models. Also compare with the quasi-steady solution

Assume the baseline geometry provided in the course AE4135 Rotor-wake aerodynamics:

Baseline design of the wind turbine rotor

Rotor Specs	
Radius	50 m
# of blades	3
Blade starts at	0.2 r/R (before that circular root section without influence)
Twist	14*(1-r/R) (for r/R>0.2)
Blade pitch	-2 degrees
Chord distribution function	(3*(1-r/R)+1) m (for r/R>0.2)
Airfoil	DU 95-W-180
Rotor yaw angle	0 degrees
Operational Specs	
U0	10 m/s
TSR (lambda)	10

The group will evaluate the operation of the rotor under different dynamic inflow conditions.

Case A: Dynamic inflow due to change in rotor configuration

Case A.1 Step change in thrust coefficient

CT at t0	CT at t1=infinity (use equivalent steady setup)
0.5	0.9
0.9	0.5
0.2	1.1
1.1	.4

Case A.2 Sinusoidal change in quasi-steady thrust coefficient **CT=CT0+Delta_Ct*sin(omega*t)**

CT0	Delta_CT	Omega*R/Uinf
0.5	0.5	0.05-0.3, every 0.05
0.9	0.3	0.05-0.3, every 0.05
0.2	.7	0.05-0.3, every 0.05

Case B: Dynamic inflow due to change in wind speed

Case B.1 Step change in Uinf (keep the same rotational speed)

Uinf/U0 at t0	Uinf/U0 at t1=infinity
1	1.5
1	.7
1	1.2
1	.9

Case B.2 Sinusoidal change in Uinf**=U1+DeltaU*sin(omega*t)*cos(azimuth) (azimuthal variation is optional)**

U1/U0	DeltaU	Omega*R/Uinf
1	0.5	0.05-0.3, every 0.05
.7	0.3	0.05-0.3, every 0.05
1.2	.5	0.05-0.3, every 0.05

Deliverables:

1. Plot the loading at different locations of the blade, including the flow field induction parameters, angle of attack and inflow angle.
2. Discuss the effect of spanwise location in the level of unsteadiness
3. Show a fluxogram of your code

Start Date

19 May, 2021 09:00

Due Date

06 June, 2022 23:59

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