Series N°: 4

Exercise n° 1

A wind turbine has a rotor radius of **25 meters** and operates at a wind speed of **10 m/s**. The air density is **1.225 kg/m³**, and the power coefficient (Cp) is **0.40**. Calculate the power extracted from the wind.

Exercise n° 2

Using the same turbine as in Exercise 1 (R=25m, Cp=0.40, ρ=1.225kg/m3), calculate the power extracted at wind speeds of 5 m/s, 10 m/s, and 15 m/s. How does wind speed affect the power output?

Exercise n° : 3

A wind turbine operates at a wind speed of **12 m/s** with a power coefficient of **0.42** and air density of **1.225 kg/m³**. Calculate the power extracted for rotor radii of **20 meters** and **40 meters**. How does the rotor radius affect the power output?

Exercise n° : 4

A wind turbine has a rotor radius of 30 meters and operates at a wind speed of 10 m/s with a power coefficient of 0.40. Calculate the power extracted at sea level (ρ=1.225kg/m3) and at a high-altitude location (ρ=1.0kg/m3). How does air density affect the power output?

Exercise n° : 5

A wind turbine has a rotor radius of **35 meters** and operates at a wind speed of **12 m/s** with an air density of **1.225 kg/m³**. Calculate the power extracted for power coefficients of **0.35** and **0.45**. How does the power coefficient affect the power output?

Exercise n° : 5

A wind turbine operates at a wind speed of **10 m/s** and a rotor speed of **20 rpm**. The rotor radius is **30 meters**, and the power coefficient (Cp) is given by:

$$C_p(\lambda) = 0.5 \sin\left(\frac{\pi(\lambda - 2)}{15}\right) - 0.02(\lambda - 7)^2$$

Calculate the tip-speed ratio (λ) and the power coefficient (Cp).

Exercise n°6 :

A wind turbine extracts **1.5 MW** of power from the wind at a rotor speed of **15 rpm**. Calculate the mechanical torque produced by the turbine.

Exercise n°7 :

A DFIG has the following parameters:

- Stator resistance (Rs) = **0.01 Ω**,
- Rotor resistance (Rr) = **0.02 Ω**,
- Stator inductance (Ls) = **0.1 H**,
- Rotor inductance (Lr) = **0.15 H**,
- Mutual inductance (Lm) = **2.5 H**,
- Number of pole pairs (p) = **2**.

The stator voltage is **690 V (line-to-line)**, and the rotor speed is **1800 rpm**. Calculate the stator frequency and the slip.