Series N°: 5

Exercise n° 1

- A wind turbine with a PMSG has the following parameters:
  - Stator voltage (V_s) = 690 V (line-to-line)
  - Stator current (I_s) = 500 A
  - Power factor (PF) = 0.95 lagging
  - Generator efficiency (η) = 96%
- Calculate:
  a) The output electrical power.
  b) The mechanical input power.
  c) The torque if the rotor speed is 15 rpm.

Exercise 2 :

A **Permanent Magnet Synchronous Generator (PMSG)** has **48 poles** and operates at a rotor speed of **150 rpm**.

1. Calculate the **electrical frequency (Hz)** of the generated voltage.
2. If the generator is connected to a **50 Hz** grid, what rotor speed (in rpm) is required for synchronization?

Exercise 3 : A **2 MW PMSG** has the following losses at rated load:

- **Copper losses (stator I^2R):** 30 kW
- **Iron losses (core losses):** 20 kW
- **Mechanical losses (friction & windage):** 10 kW
- **Stray load losses:** 5 kW

Calculate:

1. The **total losses** and **efficiency** at rated load.
2. The **efficiency at 50% load**, assuming copper losses vary with the square of the load and other losses remain constant.

Exercise 4 .

A direct-drive PMSG for a wind turbine operates at **12 RPM** and must generate power at **50 Hz** for grid synchronization.

1. Calculate the **number of poles** required.
2. If the turbine's gearbox is removed (direct-drive), how does this affect pole count compared to a geared system running at 1500 RPM?

Exercise 5 .

A PMSG in a wind turbine produces **690 V (line-to-line)** at 15 RPM with 80 poles. The stator has:

- 120 turns per phase
- Winding factor k_w=0.96
- Flux per pole ϕ=0.2 Wb

1. Calculate the **generated voltage per phase** and verify if it matches the rated voltage.
2. If wind speed decreases, reducing rotor speed to **10 RPM**, what happens to the voltage? How does the converter maintain grid compatibility?