

Mechanical Engineering for Renewable Energy Systems

Wind Turbines

Dynamics

3 lectures Hugh Hunt

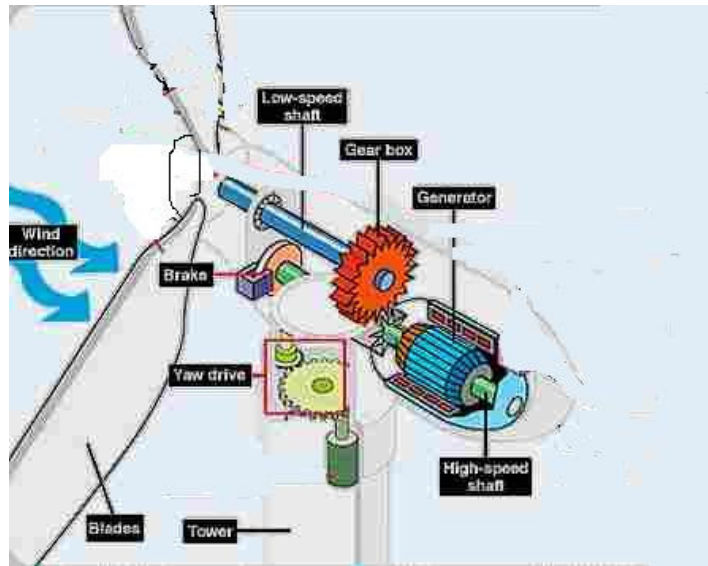
Topics to be covered are as follows:

- 6.1 **Gyroscopic effects** – the forces and moments (couples, torques) caused when a spinning wind turbine undergoes yawing motion – *i.e.* rotation about its vertical axis.
 - 6.1.1 Coriolis forces on a blade element
 - 6.1.2 The gyroscopic couple of the entire rotor
 - 6.1.3 Computing moment of inertia
 - 6.1.4 Bending moments at the blade root due to gyroscopic effects
- 6.2 **Gearboxes** – the forces and moments acting on a simple gearbox.
 - 6.2.1 Types of gears – spur, helical, herringbone
 - 6.2.2 Forces acting on a gearbox that is transmitting a torque
- 6.3 **Braking effects** – the forces and moments caused when a spinning wind turbine executes an emergency stop.
 - 6.3.1 Torque required for steady deceleration
 - 6.3.2 Braking devices – disc brake and electric brake
 - 6.3.3 Sudden braking – vibration of the blades, estimate of peak stress
- 6.4 **Noise and vibration** – the mechanisms by which vibration is generated and its consequences for airborne noise generation.
 - 6.4.1 Sources of vibration – shaft rotation, gear teeth contacts, generator pole-pass
 - 6.4.2 Estimates of source frequencies
 - 6.4.3 Sound radiation – radiation efficiency
 - 6.4.5 Control of vibration and sound radiation

Bring your own writing paper to these lectures.

Components of the **drive train** of a wind turbine showing:

1. gearbox
2. yaw drive
3. brake
4. generator



Gears



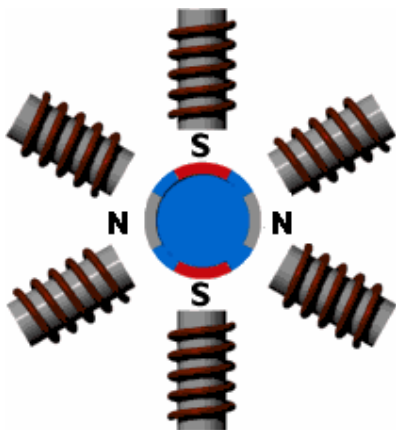
Helical gears



Spur gears



Herringbone



A four-pole 3-phase generator

The permanent magnet core has four poles.

It generates pulses of torque each time a pole passes a coil, hence there are 12 pulses per revolution