CAI335 SOLAR AND WIND ENERGY SYSTEM

UNIT IV NOTES

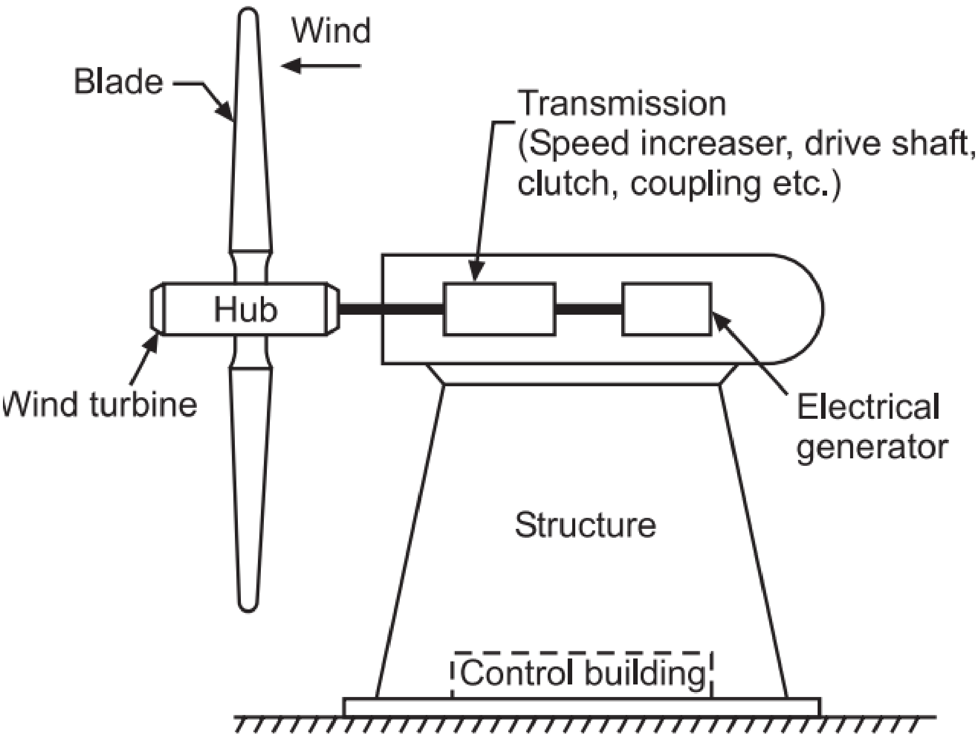
WIND TURBINE COMPONENTS AND POWER CURVE

4.2 Components of Wind mill

The components are 1. Wind turbine or rotor. 2. Wind mill head–it houses speed increaser, drive shaft, clutch, coupling etc. 3. Electrical generator. 4. Supporting structure.

The most important component is the rotor. For an effective utilisation, all components should be properly designed and matched with the rest of the components.

The wind mill head performs the following functions: (i) It supports the rotor housing and the rotor bearings. (ii) It also houses any control mechanism incorporated like changing the pitch of the blades for safety devices and tail vane to orient the rotor to face the wind, the latter is facilitated by mounting it on the top of the supporting structure on suitable bearings.



. Wind-electric generating power plant.

The wind turbine may be located either unwind or downwind of the power. In the unwind location the wind encounters the turbine before reaching the tower. Downwind rotors are generally preferred especially for the large aerogenerators.

The supporting structure is designed to withstand the wind load during gusts. Its type and height is related to cost and transmission system incorporated. Horizontal axis wind turbines are mounted on towers so as to be above the level of turbulence and other ground related effects.

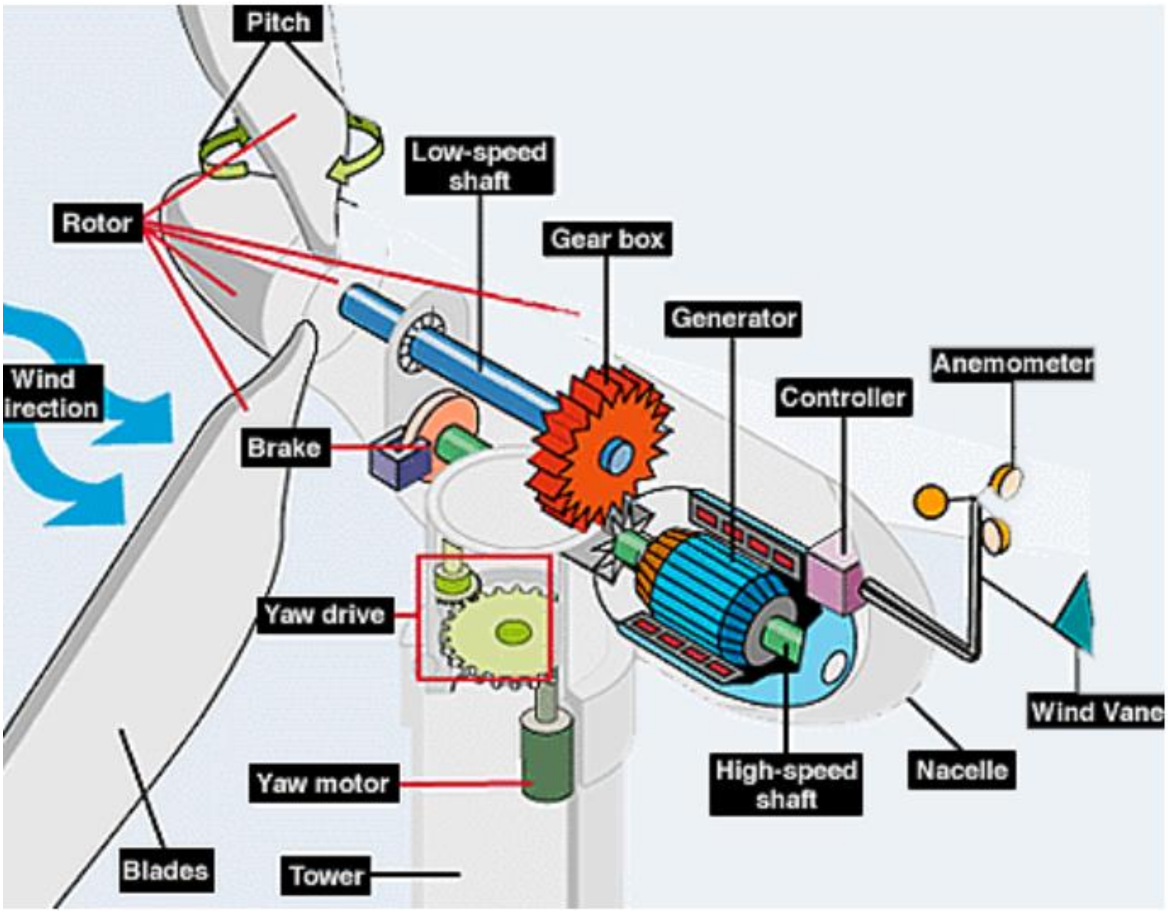


Figure: Components of wind turbine

Tower

The **tower** in most modern turbines is round tubular steel of a diameter of 3–4 m (10–13 ft), with a height of 75–110 m (250–370 ft), depending on the size of the turbine and its location. The rule of thumb for a turbine tower is that it has the same height as the diameter of the circle its blades make when rotating. Normally, the taller a turbine is, it is subject to more of the wind with higher speed. This is because the farther we are from the ground, the faster the wind (wind does not have the same speed at various distances from the ground).

Rotor

The rotor is the rotating part of a turbine; it consists of (mostly) three blades and the central part that the blades are attached to, the hub. A turbine does not necessarily have to have three blades; it can have two, four, or another number of blades. But the three-blade rotor has the best efficiency and other advantages.

Blades are not solid; they are hollow and are made of composite material to be light and strong. The trend is to make them larger (for more power), lighter, and stronger. The blades have the form of an airfoil (same as the wings of an airplane) to be aerodynamic. As well, they are not flat and have a twist between their root and their tip. The blades can rotate up to 90° about their axes. This motion is called **blade pitch**.

Hub

The function of the **hub** is to hold the blades and make it possible for them to rotate with respect to the rest of the turbine body.

Nacelle

The nacelle is housing on top of the tower that accommodates all the components that need to be on a turbine top. There are quite a number of components for the proper and healthy operation of a complicated electromechanical system that a turbine is. A major turbine part among these components is the generator and the turbine shaft that transfers the harvested power from wind to the generator through a gearbox.

The gearbox is a vital component of wind turbines; it resides in the nacelle. A gearbox increases the main shaft speed from around 12–25 rpm* (for most of today’s turbines) to a speed suitable for its generator. For this reason, the shaft on the generator side is called “high-speed shaft.”

Because a turbine must follow the wind and adjust its orientation to the wind direction, its rotor needs to rotate with respect to the tower. This rotation is called **yaw motion** in which the nacelle and the rotor revolve about the tower axis.

Generator

The generator is the component that converts the mechanical energy of the rotor, harnessed from wind to electrical energy. A generator has the same structure as an **electric motor**.

At the commercial production level, all electricity generation is in the three-phase alternative current. In general, the choice of generator, therefore, is synchronous or asynchronous (induction) generator. Nevertheless, the generator associated with wind turbines, thus far, is the **induction generator** because a **synchronous generator** must turn at a tightly controlled constant speed (to maintain a constant frequency). Some of a wind turbine’s principal components

Because a generator must be rotated at a speed corresponding to the frequency of the electric network (50 or 60 Hz in most countries), it must be rotated faster than the turbine rotor. Most generators need to be turned at 1500 rpm (for 50 Hz) and 1800 rpm (for 60 Hz). In no way, it is feasible for a turbine rotor to move that fast. A gearbox, therefore, must increase the turbine rotor (main shaft) rotational speed to a speed that can be used by the generator.

All new turbines are equipped with pitch control, which implies that their blades' pitch angle can be adjusted so that the power output from a turbine is maximized at all times, while it does not overload the generator and mechanical structures of the blades, tower, and the rotor shaft.

4.3 Power Curve

The way this adjustment of power to wind speed is carried out is that each turbine has a performance curve called **power curve**. It is used as a power schedule by a computer in the turbine control system to adjust all components that need to be controlled, based on this curve and according to wind speed.

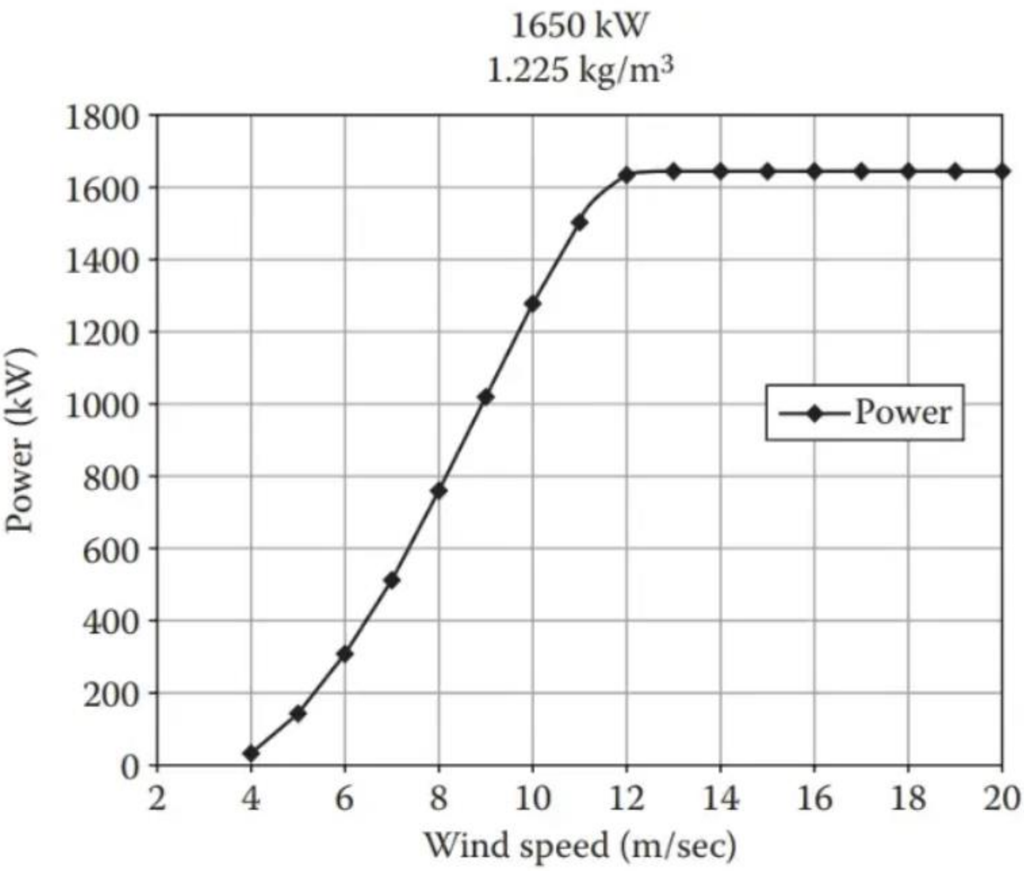


Figure :Power curve