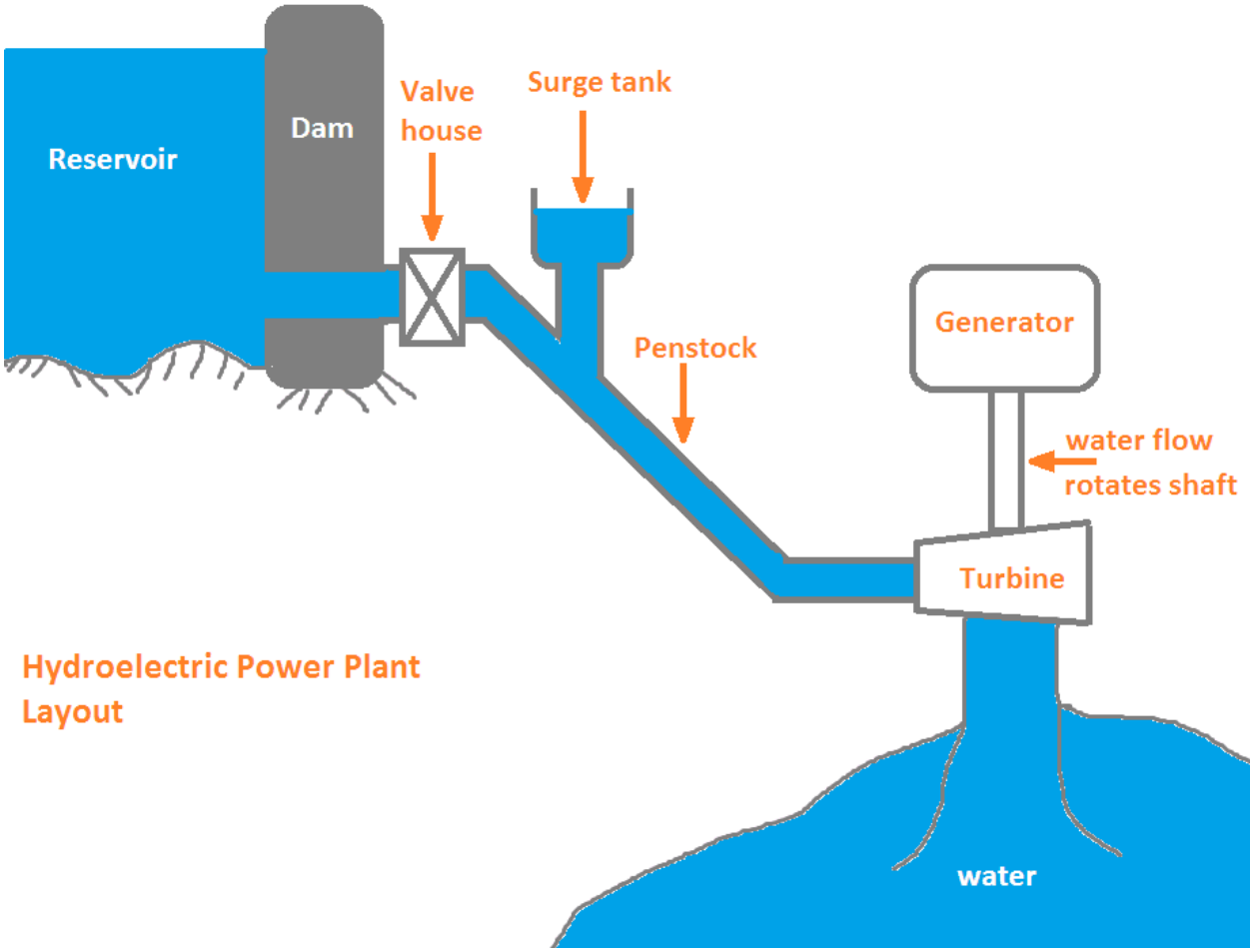
UNIT 04 : MICRO HYDRO POWER SYSTEMS

Marks:10

What is Hydro Power Systems?

* **Hydropower** or **hydroelectricity** refers to the conversion of **energy** from flowing water into electricity. It is considered a renewable **energy** source because the water cycle is constantly renewed by the sun.
* Hydropower plants capture the energy of falling water to generate electricity. A turbine converts the kinetic energy of falling water into mechanical energy. Then a generator converts the mechanical energy from the turbine into electrical energy.

❖ Hydroelectric Power Plant:



Hydroelectric Power Plant Layout

Working Principle of Hydroelectric Power Plant

- ✓ The water turbine changes the kinetic energy of the falling water into mechanical energy at the turbine shaft.
- ✓ In simple words, falling water spins the water turbine. The turbine drives the alternator coupled with it and converts mechanical energy into electrical energy.
- ✓ This is the basic "working principle of hydroelectric power plant". Hydroelectric power plants are very popular because the stores of fuels (i.e., oil and coal) are exhausting day by day. They are also beneficial for irrigation and flood control purposes.

Elements of Hydroelectric Power Plant

The main elements of a hydroelectric power plant are as follows:

1.Catchment area: The total area behind the dam in which water is collected and stream flow is obtained is known as the catchment area.

2.Reservoir: It is an important part of a power plant, where water is stored and supplied to water turbine continuously.

3.Dam: A dam is a barrier which stores water and creates water head.

4.Slip-way: Due to heavy rainfall in the catchment area, the water level may exceed the storage capacity of the reservoir. It may affect the stability of reservoir. To remove this excess water, a structure is formed around the reservoir. This structure is known as slip-way. Slip-way provides stability to the reservoir and reduces the level of water in the time of the flood.

5. **Surge Tank:** It is a small tank (open at the top). It is provided to reduce the pressure surges in the conduit. It is located near the beginning of the conduit.
6. **Penstocks:** Penstocks are open or closed conduits which carry water to the turbines. They are generally made of RCC or steel. The RCC penstocks are suitable for low water heads (< 30 m). The steel penstocks are suitable for any head; as they can be designed according to water head or working pressure.

7. Water turbines: It works as an energy conversion device. It is a machine through which potential energy of water is converted into mechanical energy of shaft. The main types of water turbines are:
(i) Impulse Turbines (ii) Reaction turbines

8. **Water Turbine Generators:** They are **low RPM (75 to 300)** synchronous generators with main exciters usually mounted at the top on the shaft end. The machines are generally air-cooled with closed circuit cooling.

❖ Hydroelectric Power Plant Advantages and Disadvantages:

Advantages:

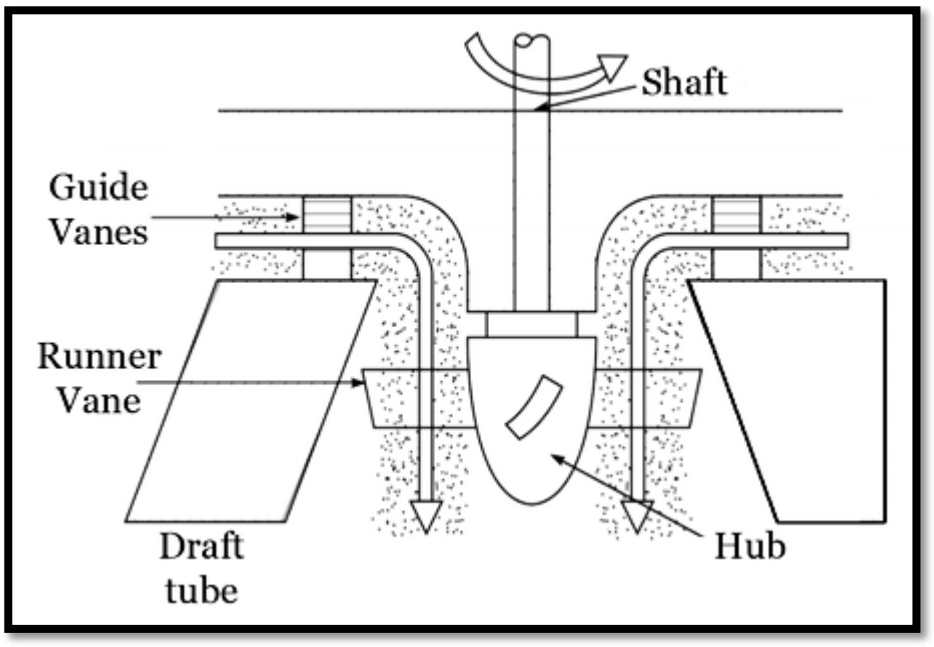
- More reliable power plant.
- Low operating cost.
- Low starting time.
- High production rate capacity.
- Fuel cost is zero.
- Pollution free.
- Renewable source of energy.
- Life of power plant is more.
- Also used in flood control and in irrigation.

Disadvantages

- Capital cost is high.
- Depends upon availability of water.
- Commonly found in hill-areas.
- Apparatus needs corrosion protection.

KAPLAN TURBINE

Kaplan Turbine works on the principle of axial flow reaction. In axial flow turbines, the water flows through the runner along the direction parallel to the axis of rotation of the runner. The water at the inlet of the turbine possesses both kinetic energy as well as pressure energy for effective rotation the blades in a hydro-power station.



The main parts of Kaplan Turbine are,

1. Scroll Casing

It is a spiral type of casing that has decreasing cross section area. The water from the penstocks enters the scroll casing and then moves to the guide vanes where the water turns through 90° and flows axially through the runner. It protects the runner, runner blades guide vanes and other internal parts of the turbine from an external damage.

2. Guide Vane Mechanism

It is the only controlling part of the whole turbine, which opens and closes depending upon the demand of power requirement. In case of more power output requirements, it opens wider to allow more water to hit the blades of the rotor and when low power output requires it closes itself to cease the flow of water. If guide vanes is absent than the turbine can not work efficiently and its efficiency decreases.

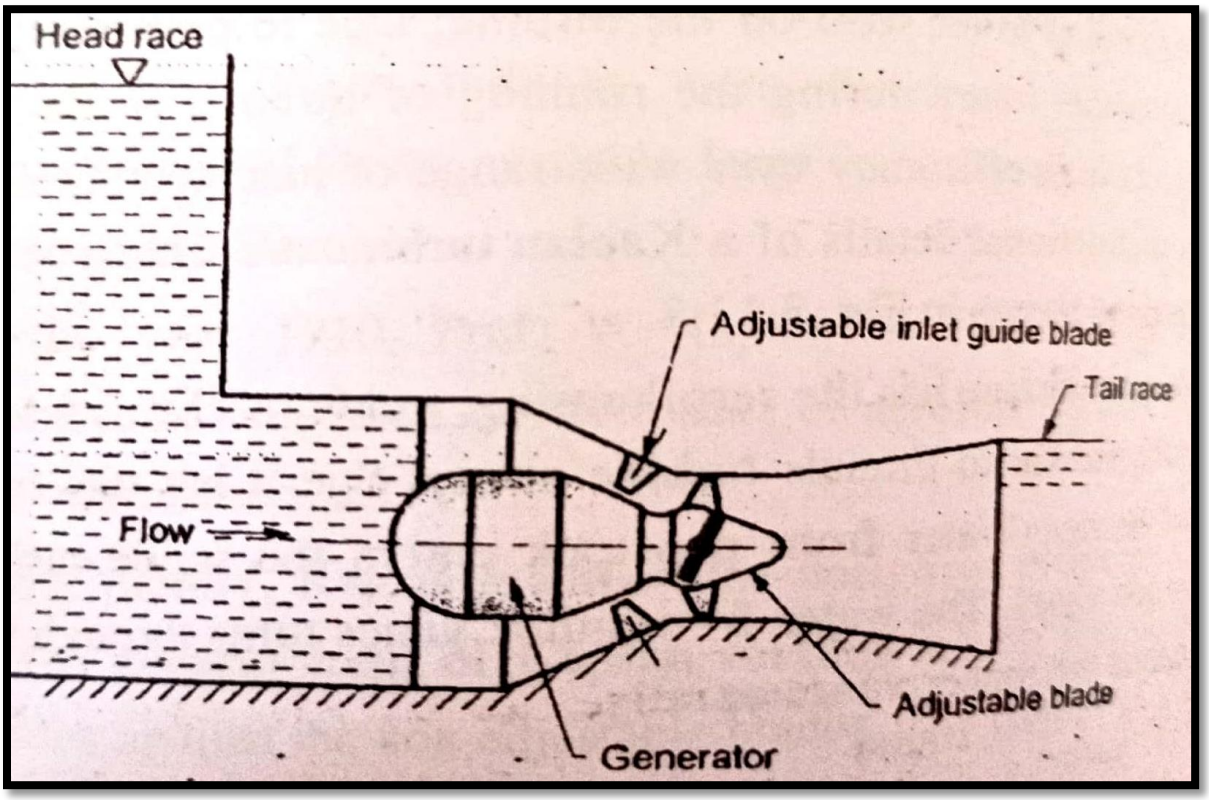
3. Draft Tube

The pressure at the exit of the runner of Reaction Turbine is generally less than atmospheric pressure. The water at exit cannot be directly discharged to the tail race. A tube or pipe of gradually increasing area is used for discharging water from the exit of turbine to the tail race. This tube of increasing area is called Draft Tube. One end of the tube is connected to the outlet of runner while the other end is sub-merged below the level of water in the tail-race.

4. Runner Blades

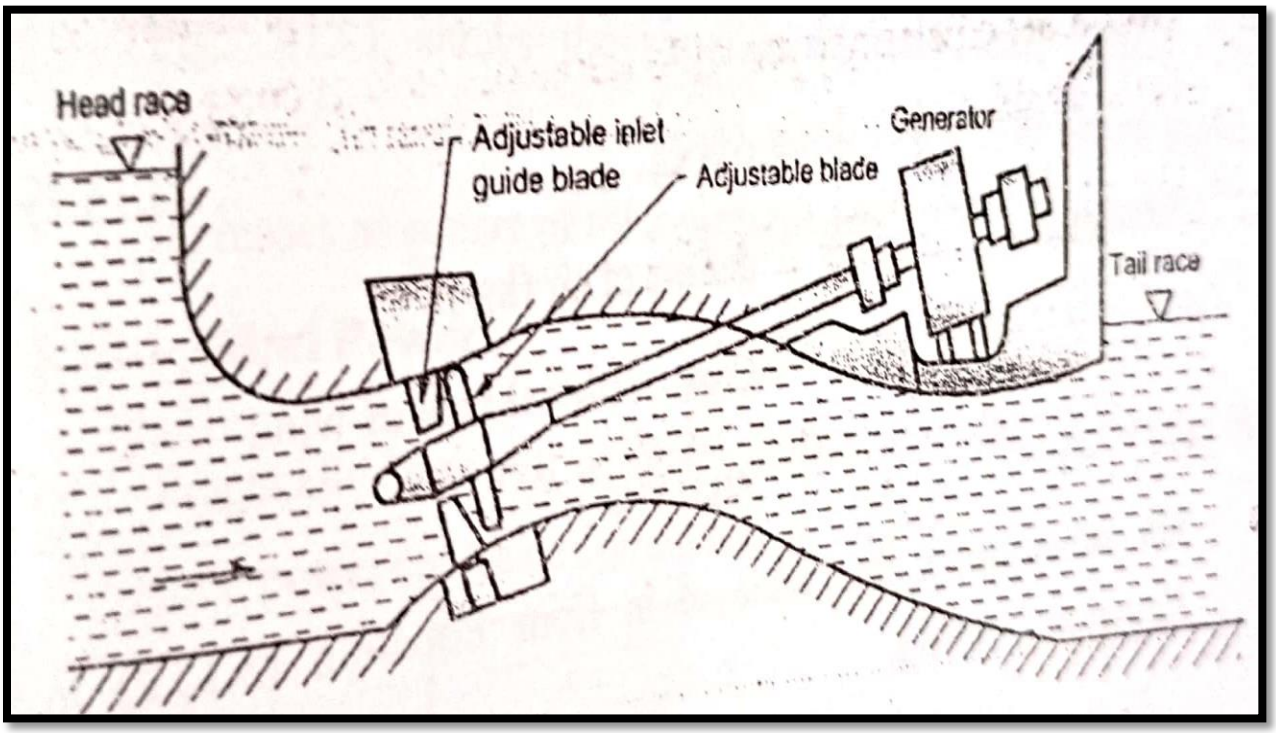
The heart of the component in kaplan turbine are its runner blades, as it the rotating part which helps in production of electricity. Its shaft is connected to the shaft of the generator. The runner of the this turbine has a large boss on which its blades are attached and the the blades of the runner is adjustable to an optimum angle of attack for maximum power

AXIAL FLOW BULB TURBINE:



- ✓ It is an axial flow turbine used for generation of power for very low head applications upto 12m.
- ✓ In this turbine the inlet guide blades & impeller blades are both adjustable.
- ✓ The turbine drives a generator housed in a bulb shaped enclosure , both turbine & generator units are housed in.

❖ AXIAL FLOW TUBULAR TURBINE:



- ✓ The modified axial flow turbines for operation under low heads are called tubular turbines.
- ✓ These are suitable for tidal energy & for applications as canal plants.
- ✓ The arrangement of a tubular turbine plant with inclined shaft is shown in fig. The turbine has adjustable inlet guide blade & impeller blades may be fixed or adjustable.
- ✓ The turbine is mounted inside a tube. It may be horizontal or inclined.
- ✓ Inclined shaft mounted turbine has the advantage since turbine shaft can be taken out of water passage & connected to generator which is kept outside the tube.