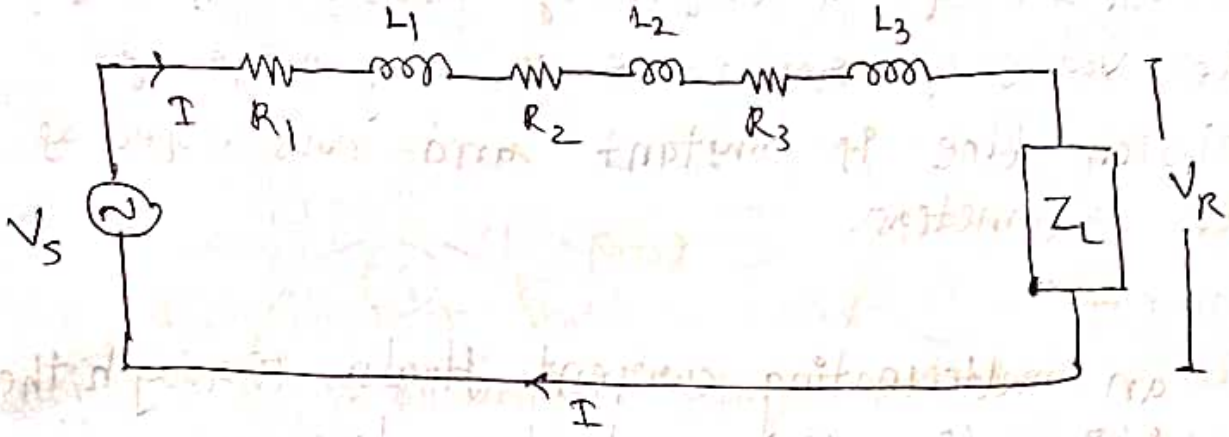
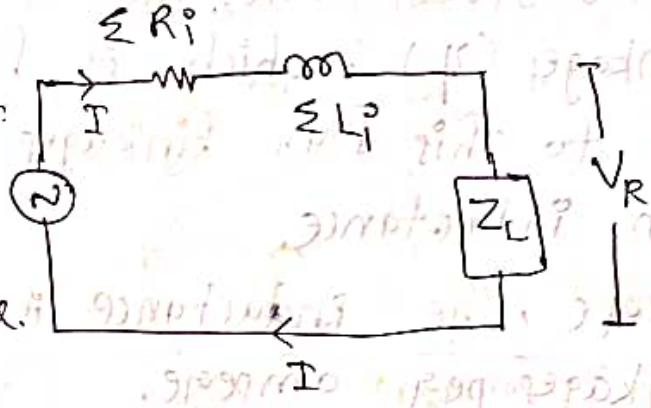
3. Basics Of Power System

Elements of Transmission Line:-

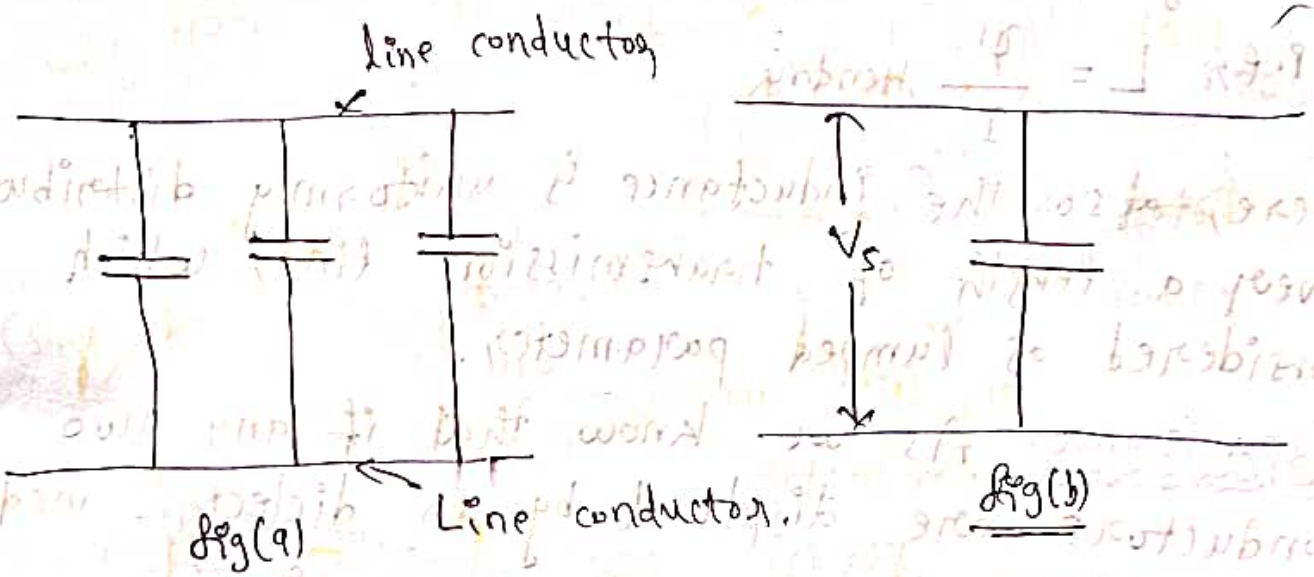




Elements / Constants / Parameters:

V_s = Sending end voltage V_s

V_R = Recieving end voltage.



Fig(a) Fig(b)

There are three basic elements (or constants or parameters) are considered in transmission lines where, these parameters are uniformly distributed along the whole length of wire (or) line.

Resistance:- As we know that the property of resistor will opposes the flow of current. In case of transmission line, the resistance is uniformly distributed over a length of transmission line. i.e, the value of resistance at any point of transmission line is constant and considered as lumped parameters.

Inductance:-

When an alternating current flows through the transmission line, the conductor develops a flux linkages (ψ), which is links with the conductor. Due to this flux linkages the conductor offers its own inductance.

Where, the inductance is given by the flux linkages per ampere.

i.e, $L = \frac{\psi}{I}$ Hendry.

Here, also the inductance is uniformly distributed over a length of transmission line, which considered as lumped parameter.

Capacitance:- As we know that if any two conductors are displaced by an dielectric medium, will exhibits the property of capacitor.

From fig(b), Here, two line conductors of an transmission lines are displaced by an dielectric medium of air, such that the capacitance will exists between these two line conductors.

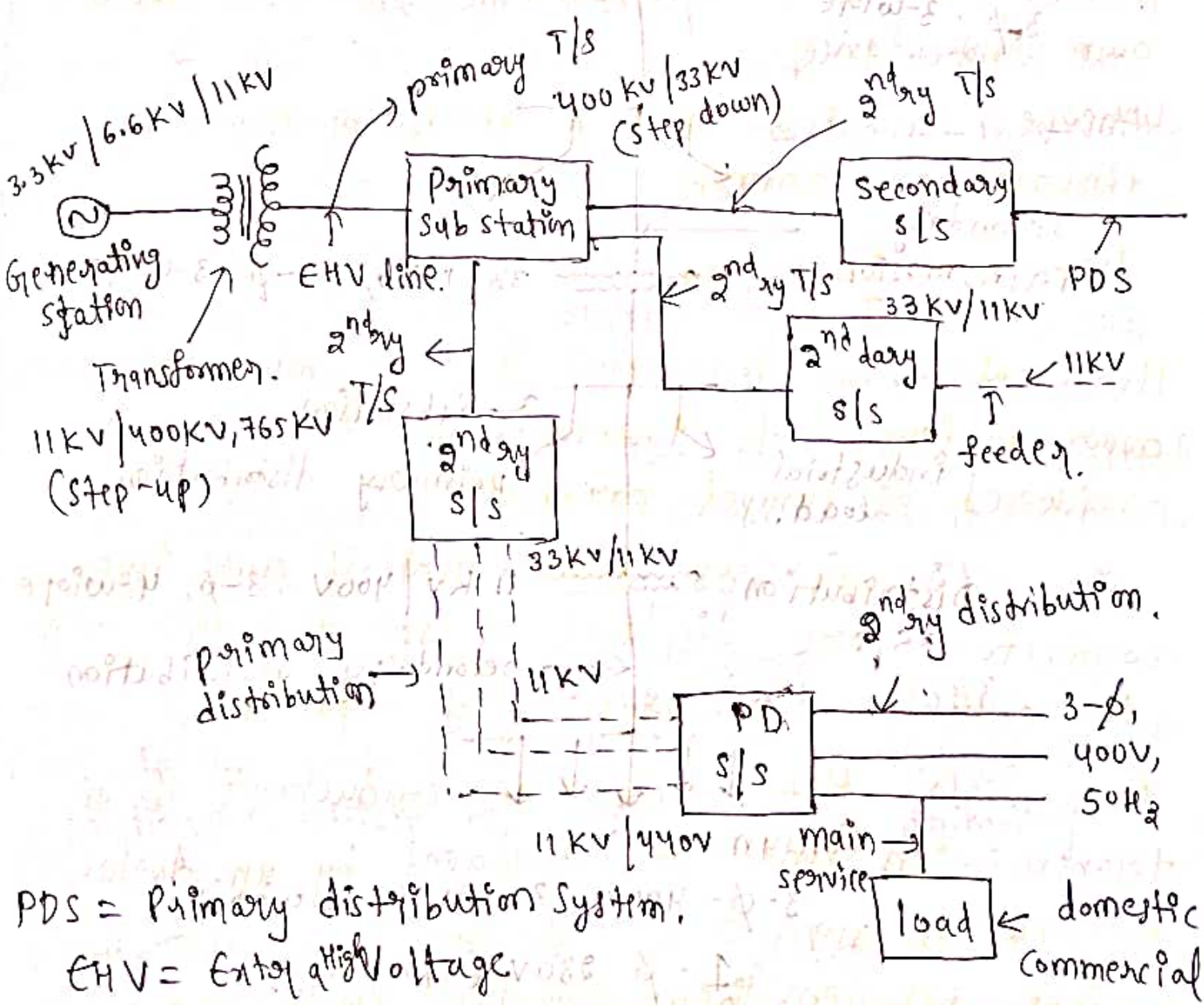
where, the capacitance is given by

i.e, $C = \frac{q}{V}$ farads

Here, also the capacitance is uniformly distributed over a length of transmission line, which considered as lumped parameters.

Types of distribution System:

The distribution systems are classified based on their voltage readings. There are mainly two types of distribution systems. Which are given by primary distribution system & secondary distribution system.

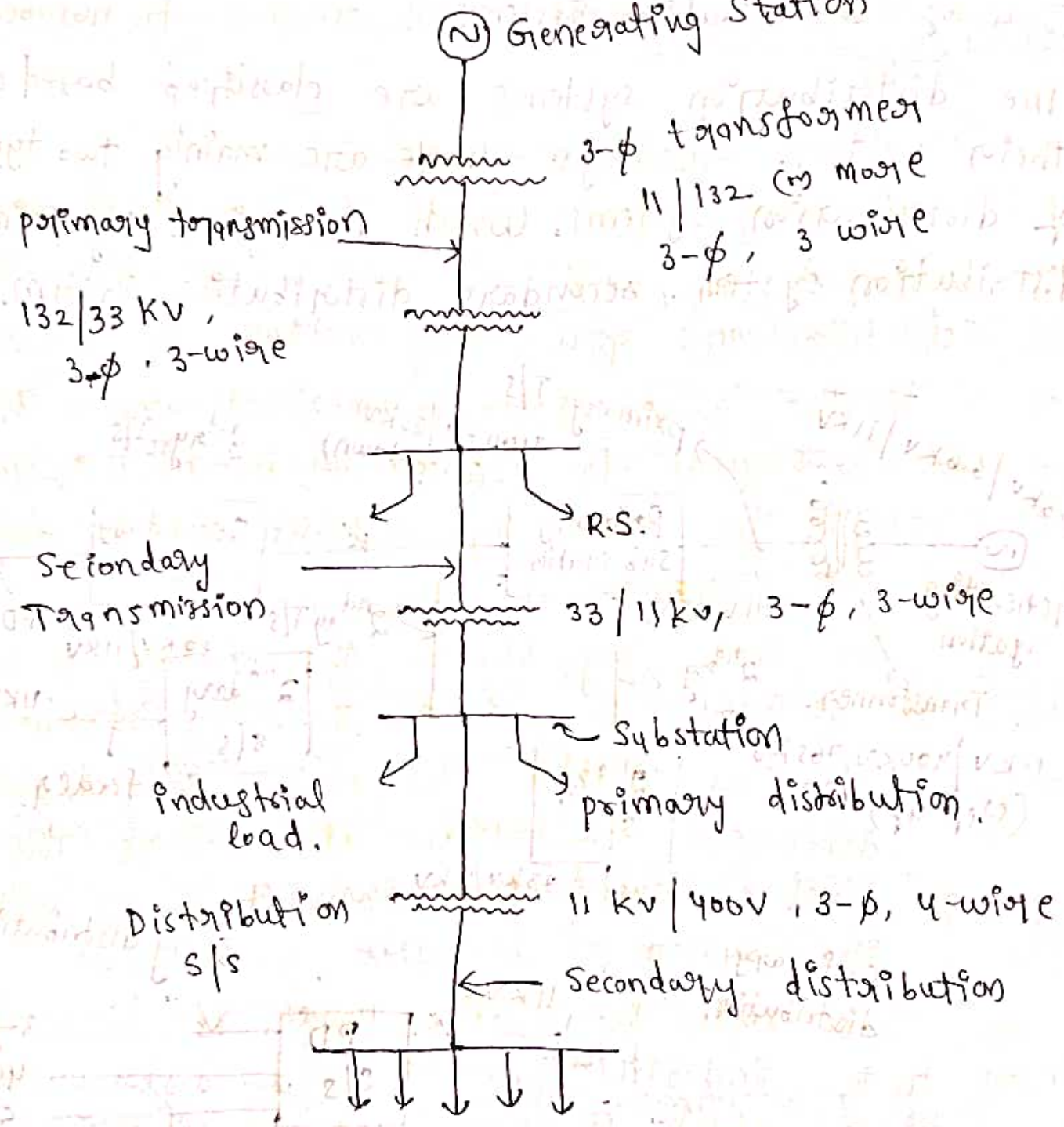


PDS = Primary distribution System.

EHV = Extra high Voltage

Typical AC power supply scheme:

The power transmission from the generating station to consumer end is explained by considering it's single line diagram or a layout of power supply scheme. This layout clearly explains the power transmission at various stages.



The power transmission b/w the generating stations to the consumers is mainly devided into 2 parts.
(i) Transmission System, (ii) Distribution System, where these two systems again classified into two types.
(i) Primary, (ii) Secondary. at each stage the voltage level is changes with respect to number of wires.

Generating Stations:-

The GS is the place, where the electrical power is developed by 3-ϕ alternators operating in parallel. Here the generating voltage is 11 KV is given to the 3-ϕ transformer at which the voltage is step up to 132 KV (or more. This voltage is given to the recieving stations, which are located at outputs of city.

where, in recieving station the voltage is step down to 33 KV with 3-ϕ, 3-wire system.

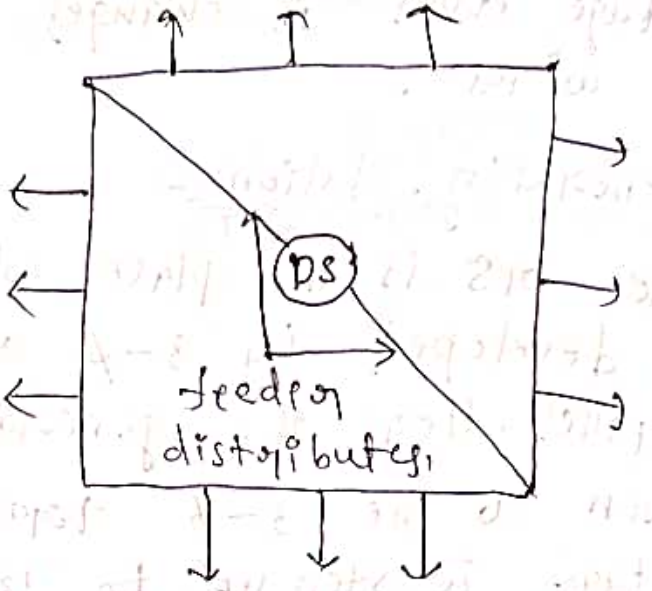
From recieving station the power is transmitted to the different substations and where the voltage level changed from 33KV to 11 KV with 3-ϕ, 3-wire system.

From these substations the power is directely given to the industrial loads and distribution sub stations, which is considered as primary distribution.

In distribution substation the voltage level is step down to 400 volts with 3-ϕ, 4-wire system.

and it is given to the consumers, which is considered as secondary distribution.

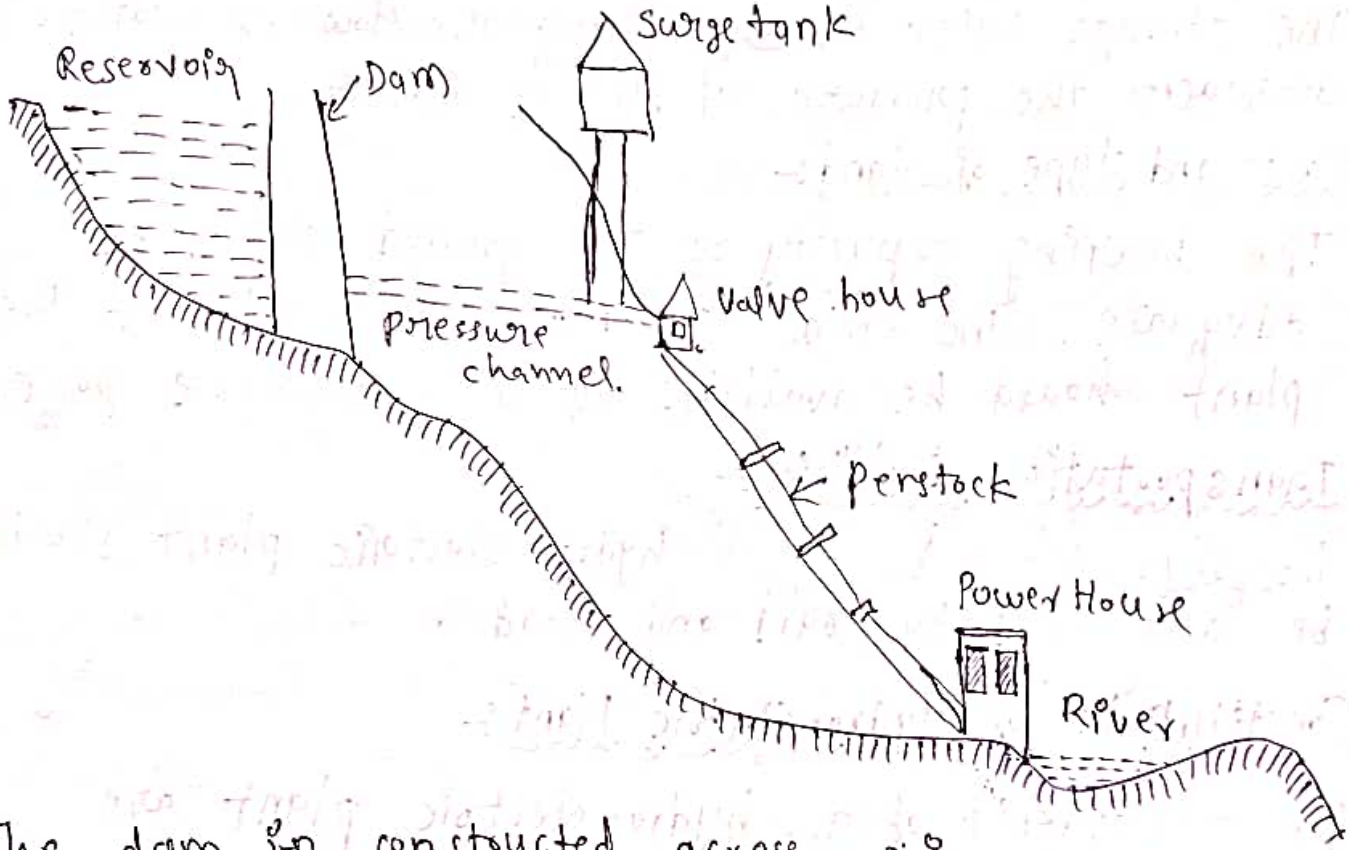
Where, the consumers either 3-ϕ, 400V (3-wire (or) 4 wire) and 1-ϕ, 230V (1-Ph, 1-N) at consumers side the distribution consist of feeders, service mains and distributers.



UNIT-3 :- Basic of Power System

Hydro Power Plant :-

It involves the conversion of hydraulic energy into electrical energy. The schematic arrangement of hydro electric plant is shown below.



The dam is constructed across a river or lake.
A pressure tunnel is taken off from the reservoir and water brought to the valve house at the start of the penstock.
From the valve house, water is taken to water turbine through a huge steel pipe known as penstock.
The water turbine converts hydraulic energy into mechanical energy. The alternator converts mechanical energy into electrical energy.
A surge tank is build just before the valve house and protects the penstock from bursting in case of turbine gates suddenly close.

Choice of site for Hydro-Electric Power Stations:-

(i) Availability of water:-

The primary requirement of a hydro-electric power station is the availability of huge quantity of water. ex:- rivers, lakes, cananals etc.

(ii) Storage of Water:-

The storage helps in equalising the flow of water. It decreases the pressure of flowing water.

(iii) Cost and type of land:-

The bearing capacity of the ground should be adequate. The land for the construction of the plant should be available at a reasonable price.

(iv) Transportation facilities:-

The site selected for a hydro-electric plant should be accessible by rail and road.

Constituents of Hydro-Electric Plant:-

The constituents of a hydro-electric plant are

(i) Hydralic structures
(ii) Water turbines and
(iii) Electrical equipments.

Hydralic structures:-

It includes dam, spillways, headworks, surge tank, penstock and accessory works.

Dam:- A dam is a barrier which stores water. Dams are built of concrete (or) stone masonary, earth (or) rock fill. The type of dam also depends upon the foundation conditions, local materials and transportation available, occurrence of earthquakes.

Spillways:-

In order to discharge the water from the storage reservoir into the river spillways are used. Spillways are constructed of concrete piers on the top of the dam. Gates are provided between these piers. Water is discharged over the crest of the dam by opening these gates.

Headworks:-

Headworks are used to controlling the flow of water to the turbine. The headworks consists of the diversion structures. Headworks generally include booms and racks for diverting floating debris, sluices and valves.

Surge tank:-

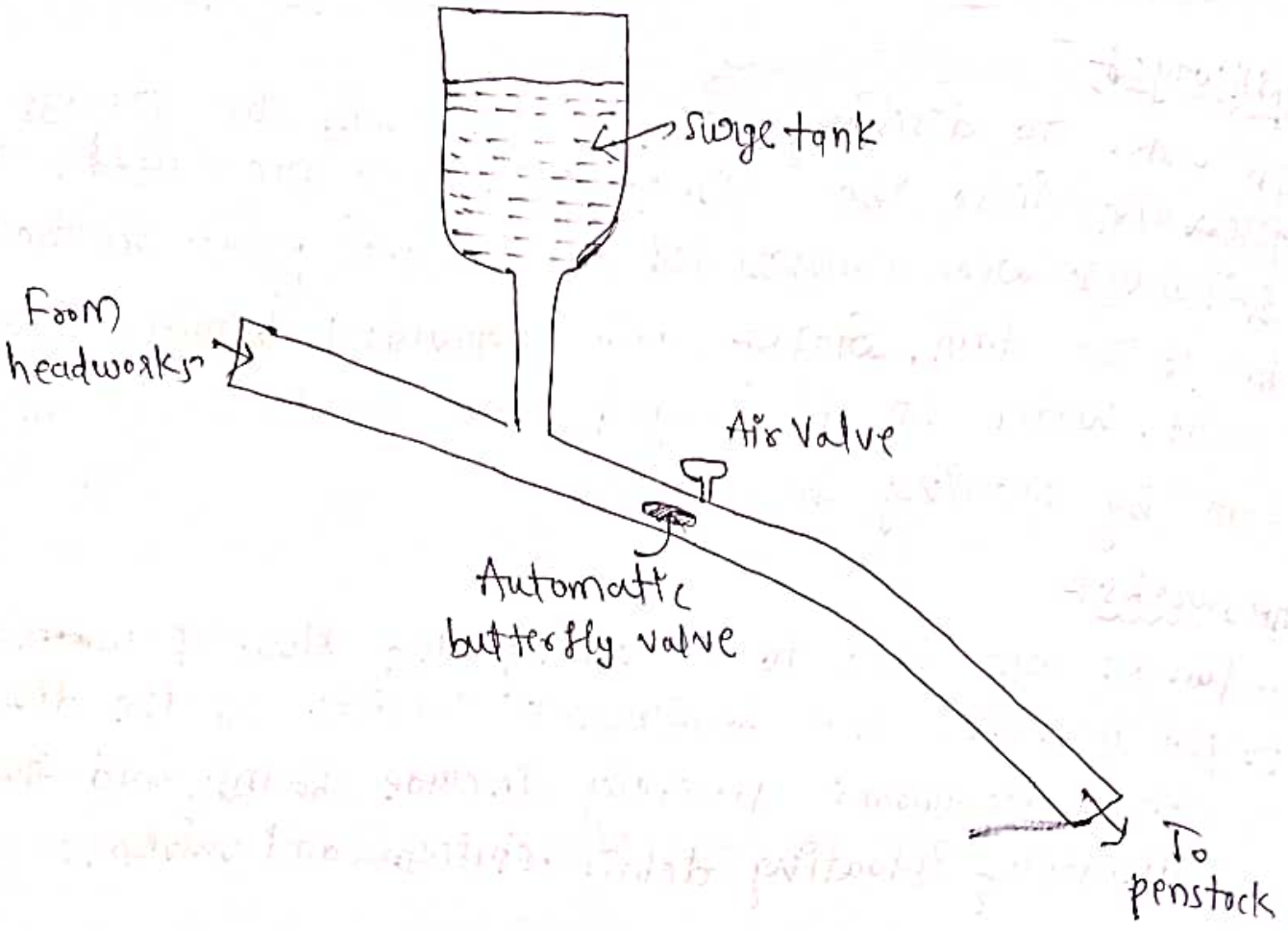
A surge tank is a small reservoir or tank (open at the top) in which water level rises or falls to reduce the pressure

Penstocks:-

Penstocks are open or closed conduits which carry water to the turbines. They are generally made of concrete (or) steel.

Automatic butterfly valve, air valve and surge tank are provided for the protection of penstocks.

Air valve maintains the air pressure inside the penstock equal to outside atmospheric pressure.



Thermal Power Station:-

A generating station which converts heat energy of coal combustion into electrical energy is known as a steam power station.

A steam power station works on the Rankine cycle. The steam turbine drives the alternator which converts mechanical energy of the turbine in to electrical energy.

This type of power station is suitable where coal and water are available in abundance and large amount of electric power is generated.

Advantages:-

(i) The fuel ie coal used is quite cheap.

(ii) Less initial cost as compared to other generating stations.

(iii) The coal can be easily transported to the site of the plant by rail or road.
(iv) It requires less space as compared to the hydroelectric power station.

Disadvantages:-
(i) It pollutes the atmosphere due to the production of large amount of smoke and fumes.

Schematic Arrangement of Steam Power Station:-
The whole arrangement can be devided into 6 stages as follows.
(i) Coal and ash handling arrangement
(ii) steam generating plant.
(iii) Steam turbine.
(iv) Alternator
(v) Feed water.
(vi) Cooling arrangement.

1) Coal and ash handling plant:-
The coal is transported to the power station by road or rail and is stored in the coal storage plant. ~~Then~~ From the coal storage plant, coal is delivered to the coal handling plant where it is pulvarised. The pulverised coal is fed to the boiler by belt conveyors. The coal is burnt in the boiler and the ash is produced. This ash is delivered to the ash storage plant.
In a thermal power station, about 50% to 60% of the total operating cost consists of fuel purchasing and its handling.

(ii) Steam generating plant :-

The steam generating plant consists of a boiler for the production of steam.

⇒ Boiler :- The heat of combustion of coal in the boiler is utilized to convert water into steam at high temperature and pressure. The flue gases from the boiler make journey through super heater, economiser, air pre-heater and finally exhausted to the atmosphere through the chimney.

⇒ Superheater :- The steam produced in the boiler is wet and passed through superheater where it is dried and superheated. by the flue gases. The superheated steam from the superheater is fed to steam turbine through the main valve.

⇒ Economiser :-
The economiser extracts a part of heat of flue gases to increase the feed water temperature..

⇒ Air pre-heater :- The air pre heater extracts heat from flue gases and increases the temperature of air used for coal combustion.

(iii) Steam Turbine :-

The steam turbine converts the heat energy into mechanical energy. After giving heat energy to the turbine, the steam is exhausted to the condenser.

(iv) Alternator :-

The alternator converts mechanical energy of the turbine into electrical energy. The electrical output from the alternator is delivered to the bus bars Through transformers.

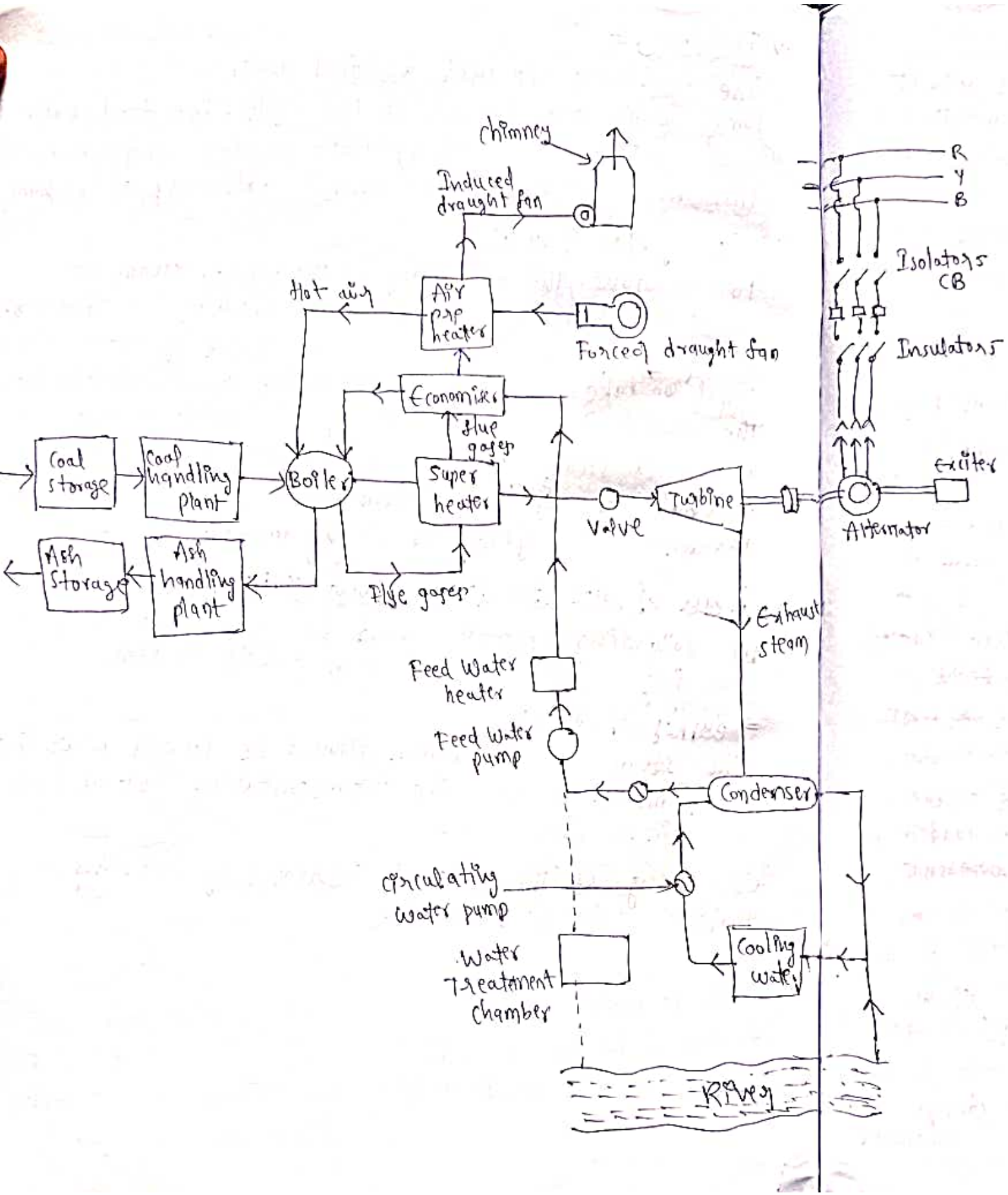
(v) Feed Water :-
The condenser is used as feed water to the boiler. Some water may be lost in the cycle. The feed water to the boiler is heated by water heaters and economisers. This helps in raising the overall efficiency of the plant.

(vi) Cooling arrangement :-
To improve the efficiency of the plant, steam is exhausted from the turbine is condensed by the condenser: water is drawn from a natural source like river, canal or lake. and it is circulated through the condenser. The circulating water takes up the heat of the exhausted steam and itself becomes hot. The availbability of water from the source is not assured throughout the year, so cooling towers are used.

Choice of site for steam power stations :-
The following points should be considered while selecting a site for a steam power station.

⇒ Supply of fuel :-
The steam power station should be located near the coal mines so that the transportation cost of fuel is min.

Efficiency of the plant is increased by reducing turbine exhaust pressure.


chimney
Induced draught fan
R
Y
B
Isolators
CB
Insulators
Hot air
Air pre heater
Forced draught fan
Economiser
Flue gases
Coal storage
Coal handling plant
Boiler
Super heater
Turbine
Valve
Exciter
Alternator
Ash Storage
Ash handling plant
Flue gases
Exhaust steam
Feed Water heater
Feed Water pump
Condenser
Circulating water pump
Water Treatment Chamber
Cooling water
River

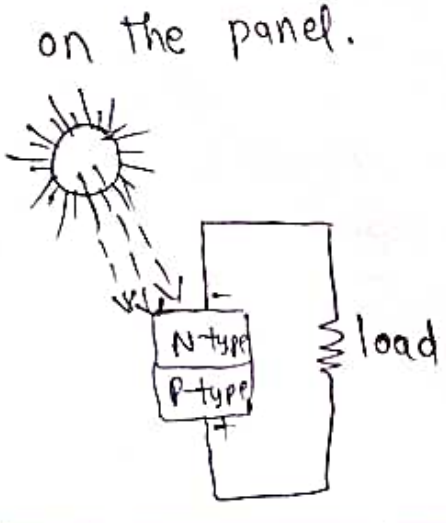
Solar Energy:-

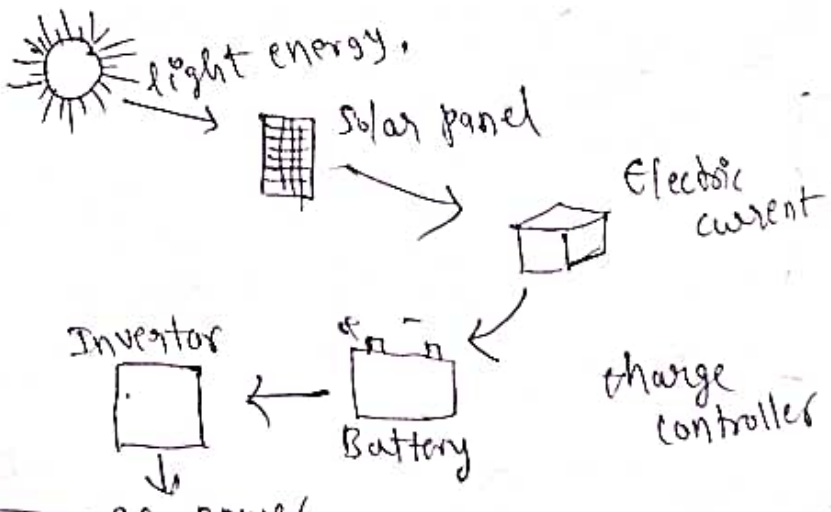
Solar energy is the reenable energy source and it can be used to need the electrical requirement such as lighting system water heating for commercial domestic and industrial application.

The essential component in solar energy system is photo volatile cell by which sunlight energy is converted into electrical current.

Operations:-

* A photo voltail cell has a p-type silicon layer placed in contact with n-type silicon layer.
* The p-type material consists of holes to accept the e^-, holes form p-N-junction like a diode. Under the influence of solar energy e^- passess from n-type material and combines with holes.
* This creates an electric charge an either side of the p-N junction to create an electric field. This field develops a potential difference across the junction.
* If an external load is connected to the solar panel, this charge difference drives the load current as long as the sunlight is present on the panel.





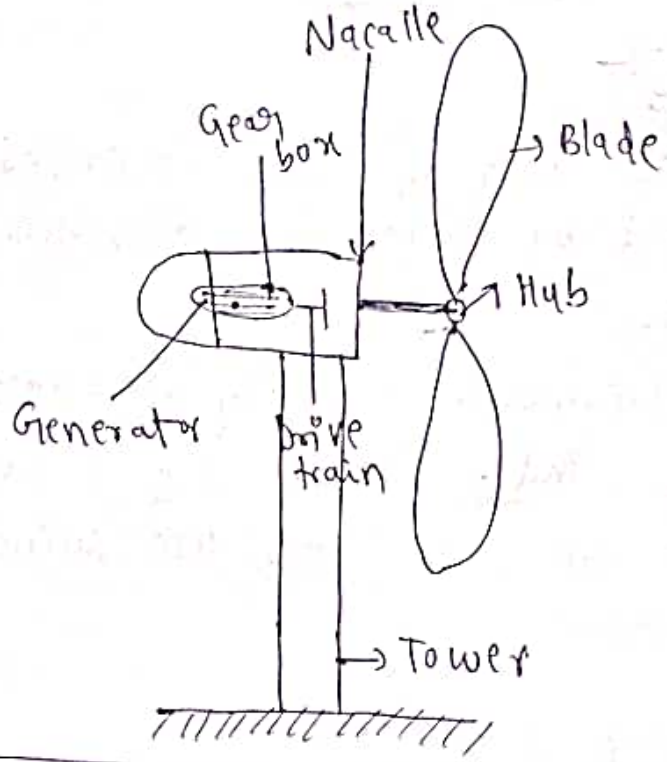
Wind Power Plant :-

The movement of air on earth is called wind. Winds are caused by pressure difference b/w different regions.

The carrying enormous quantity of energy regions in which strong winds travel for a sufficient time during the year can profitable use wind energy for different purpose.

Wind Turbine :-

* The wind turbine has its kinetic energy as if nothing but flow of atmospheric air.
* A wind turbine is a machine which utilizes the KE of wind to produce rotational mechanical energy in its shaft.
* The turbine have rotator shaft and electrical generator at the top of the tower and they must be pointed in to the wind.
* The turbine catch the winds energy with propeller like blades.
* When wind hits the blade, the blades starts rotating which causes rotates the rotator it generator.
* A series of gares is used to increase the speed of a turbine generator to produce electric AC supply.
* A stream line closer called a Nacalle, its pause s the turbine components like gare's, rotator, and generator.



Nuclear Power Station:-

A generating station in which nuclear energy is converted into electrical energy is known as nuclear power station.

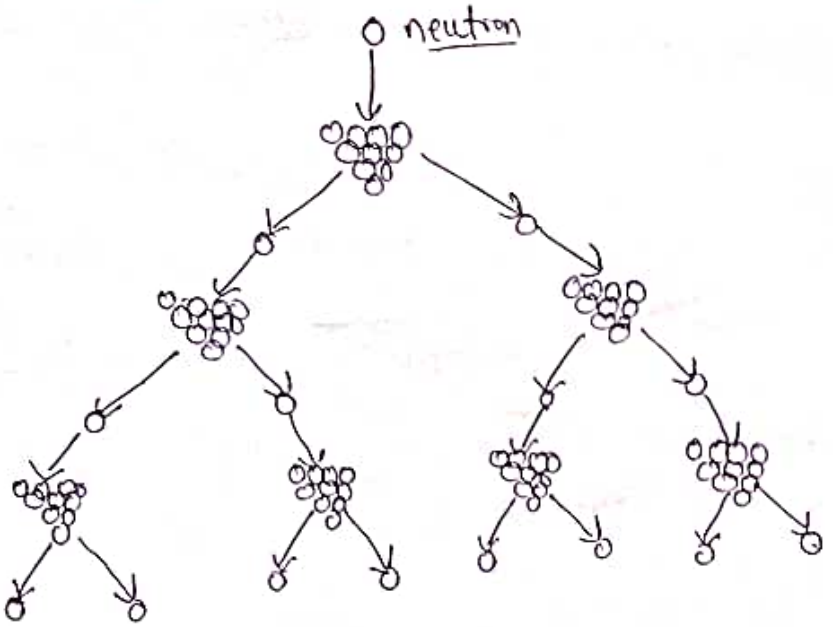
* A nuclear power station heavy elements such as Uranium (U_{235}) or Thorium (Th_{232}) are subjected to nuclear fission and it is known as reactor.

By fission and fussion heat will be generated and this head is utilize in the steam turbine.

* The steam turbine produces a mechanical energy which is fed to the generator where generator converts mechanical energy into electrical energy.

Fission:- The breaking of nuclei heavy atoms into two equal parts with huge amount of energy is known as nuclear fission.

* The release of huge amount of energy during the fission is due to mass defect. This mass defect is converted into heat energy.


neutron