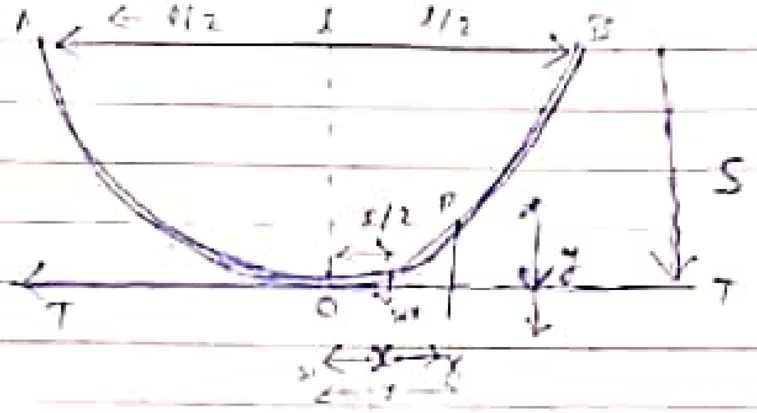
GTD **Calculation of Sag (S) :-** 28-01-2020

(i) when support are at equal level. (long question series)



l = length of span
w = weight per unit length of conductor
T = Tension in the conductor

P is ordinate point at AO

$Ty = wx \cdot \frac{x}{2}$

$y = \frac{wx^2}{2T}$ $\quad y = \frac{wx^2}{2T}$

$y = S \quad l/2 = \frac{l}{2} =$

$\boxed{y \text{ smaller}}$

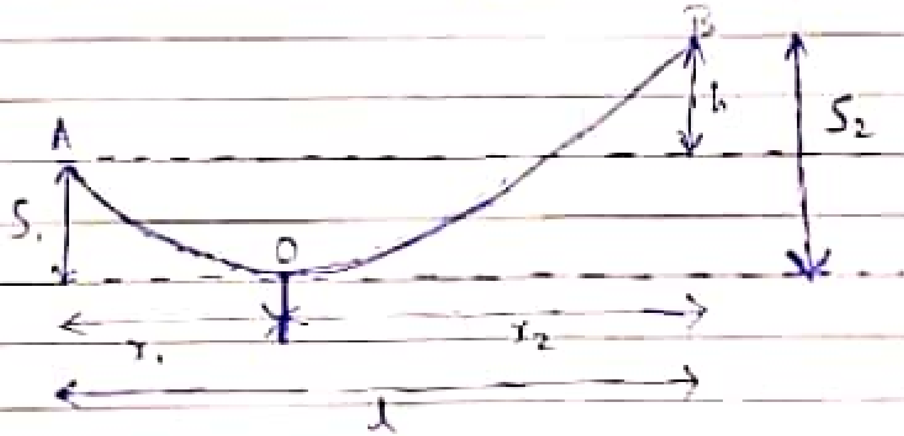
Puting into $x = l/2$, $y = S$

$y = w \times \frac{(l/2)^2}{2T} = w \times \frac{l^2/4}{2T}$

$S = \frac{wl^2}{8T}$

$\boxed{Sag = \frac{wl^2}{8T}}$

(ii) when support are at unequal level.



l = Span length
h = difference in level

1o 40

$h = S_2 - S_1$

600 / 1-

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$$V_C = V_S + I_S R/2 + j\frac{I_S X_L}{2}$$

$$V_R = V_C + \frac{I_R R}{2} + \frac{j I_R X_L}{2}$$

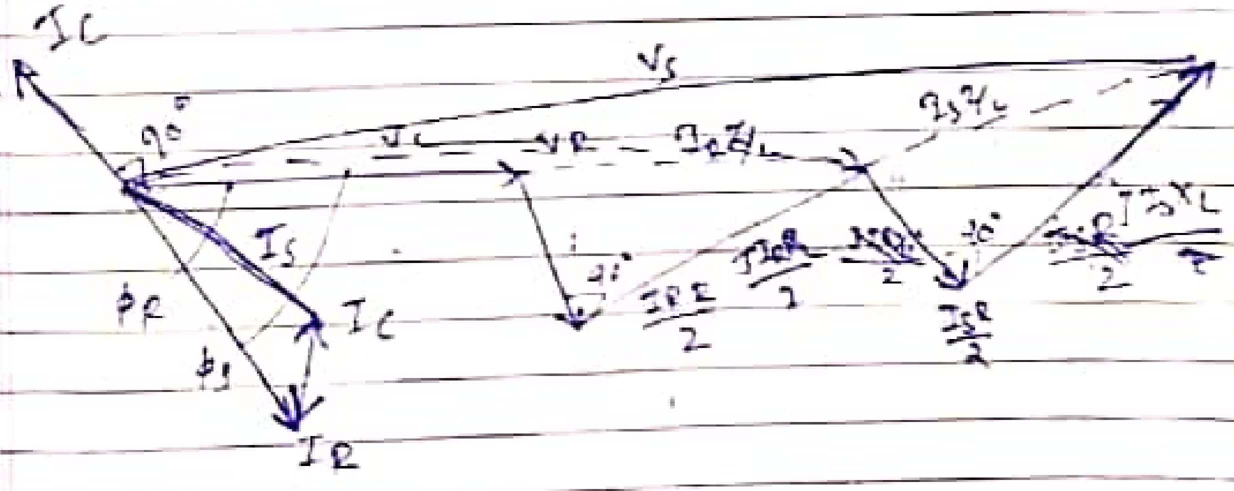
apply KVL

$$+V_S - I_S R/2 - jX_L/2 + V_C$$

$$V_S = I_S R/2 + jX_L/2 + V_C$$

$$V_C = \frac{I_R R}{2} + \frac{j I_R X_L}{2} + V_R$$

Phasor diagram :-



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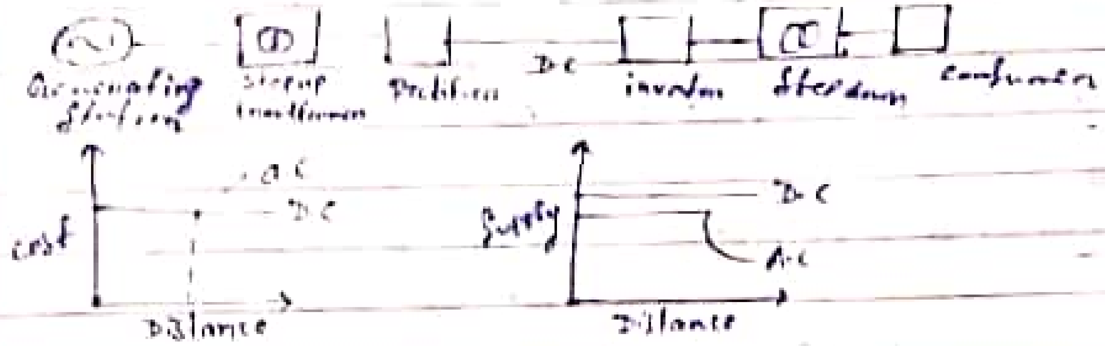
GTD

HVDC (High voltage direct current)



→ Generating Station (Steam, hydro, nuclear, etc) are located in remote area (~~conter to land~~ (biggest distance) far away from the load centre) because of the region of Economy, ~~Phy~~ feasibility at from the point of Safty and environmental condition. 'EHV' Transmission is used to transmeat huge (large) amount of power plant to load center.

→ Increses in transmission capacity of line where power transfer $P = \frac{V_S V_R}{X} \sin \delta$

δ = load angle X = line reactance

→ Power transmission capacity of a transmission line increses with increse in transmission voltage, cost of transmission line also increses in transmission voltage

Line cost:-

The line installation cost per mega watt. ~~R~~ per kilometer decreses with increse in voltage level more over the impact of the cost of losses on the overall transmission cost can be substanciesially different at different voltage level.

→ The total line cost including the cost of losses

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GTD

* Generally transmission line are classified according to their length ① Short transmission line :-
→ Transmission line of length upto 80 kilometer.
→ Effect of line capacitance is ignore because of small leakage current.

② Medium transmission line :-
→ Transmission line of length between 80 km to 160 KM.
→ Effect of capacitance is not ignore but capacitance is assumed to be lumped in the middle or at the end of transmission line.
→ Transmission line are analysed using nominal 'T' and nominal 'π' method.

③ Long Transmission line :-
→ Transmission line of length above 160 km.
→ Line can not be lumped.

~~Short~~ Voltage regulation :-

→ The difference in voltage at the receiving end of a transmission line between condition of no load and full load is called voltage regulation and it is expressed as a percentage ~~or~~ of the receiving end voltage.

$$\%\ \text{voltage regulation} = \frac{V_S - V_R}{V_R} \times 100$$

→ Efficiency = output / input   Receive / Sending

Transmission efficiency :-
The ratio of receiving end power to the sending end power of a transmission line is

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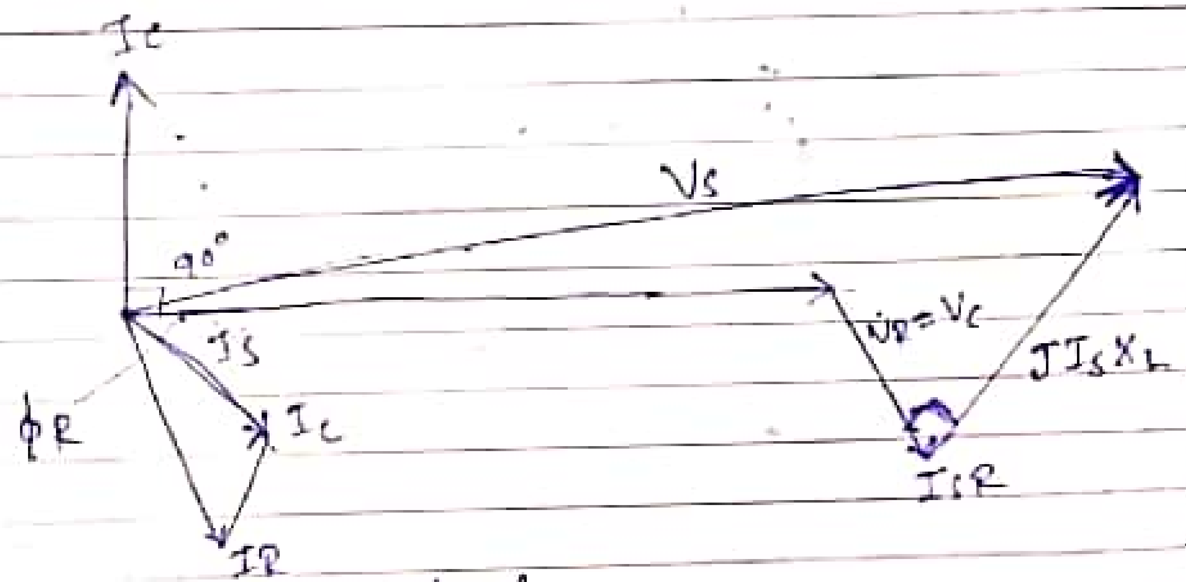
$I_s = I_c + I_R$

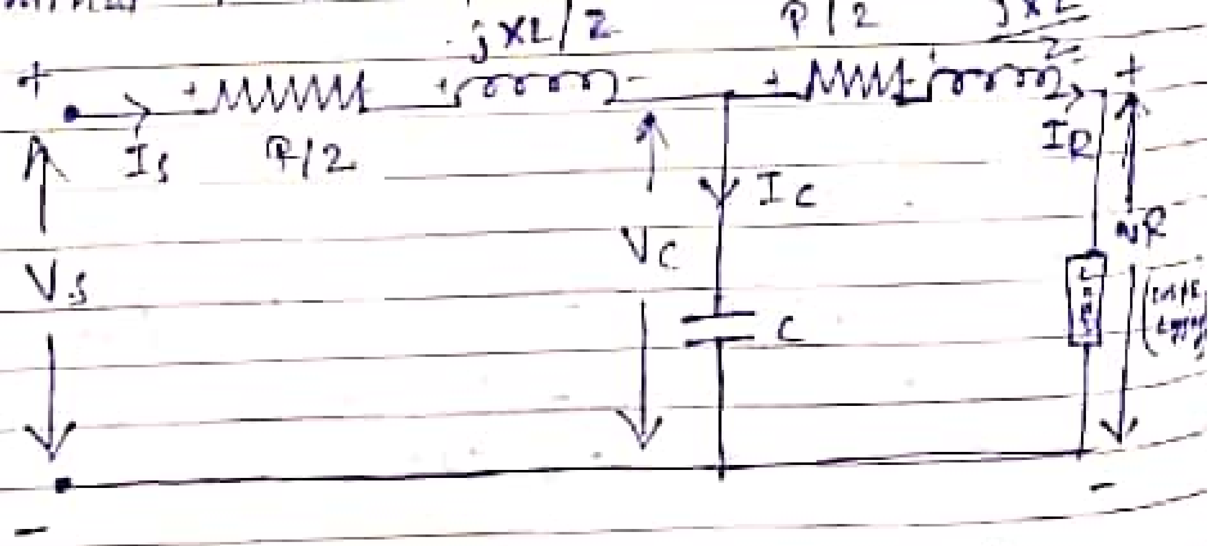
$V_S = V_R + I_S Z$

$$I_S = I_C + I_R$$
$$V_S = V_R + I_S (Z)$$
$$= V_R + I_S (R + jX_L)$$
$$= V_R + I_S R + I_S jX_L$$

Phasor diagram :-



(ii) Nominal T method



$$I_S = I_C + I_R$$

(2) Economic

Economic Considuration have lead to the Construction of power station of large capacity and so need to transfer of bulk (large) power over long distance. Transmission of bulk power from generating station to the load center is technically and economically ~~physical~~ feasible only at voltage in the EHV Range.

A
su

→ Voltage regulation :- Due to absence of inductance it has better voltage regulation.

Line loading :-

→ Generally loading on a.c line limited by transmissibility ~~limit~~ limit and line reactance but no such limit in HVDC line.

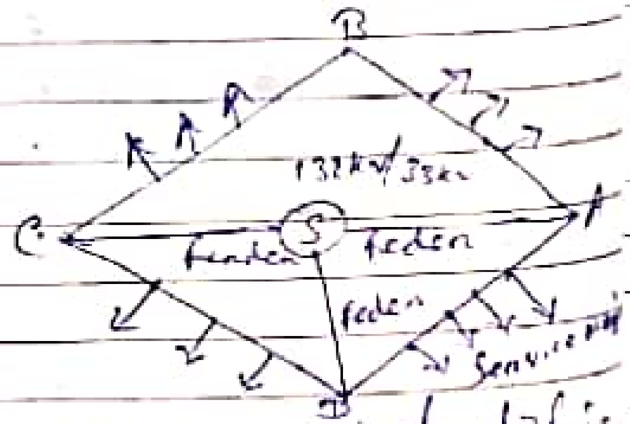
→ Low short circuit current, it has low short circuit current in HVDC

→ It has lesser corona loss and radio interference due to zero frequency.

→ Higher operating voltage ~~and~~ of ~~need to~~ no reactive power ~~compe~~ compensation, Generally HVDC system has high operating voltage with absence of reactive power compensation.

→ There is no stability limit in HVDC transmission system.

Chapter - 6 Distribution System



→ The part of electric power which distributed for local use is known as distribution system.

→ It carries electricity from transmission system to individual consumer.

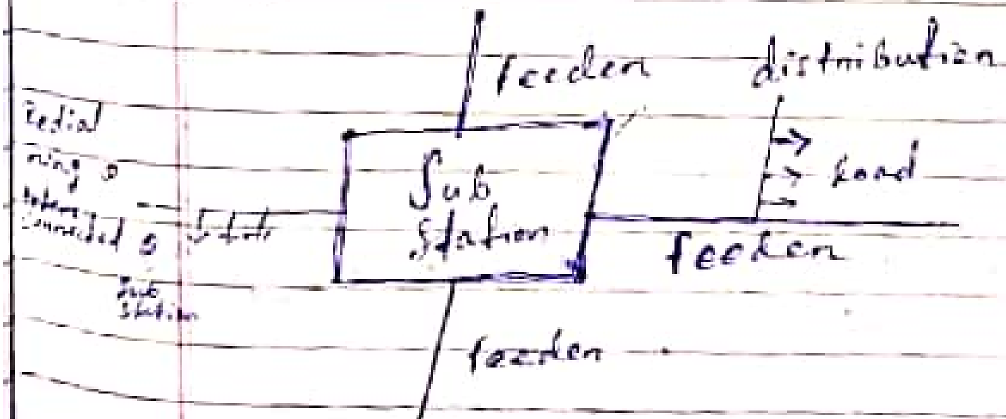
→ Distribution line mainly subdivided into feeder, distributors and service main.

Feeder :- It is a conductor which conduct electricity from substation to the area where the power is to be distributed. The feeder carry same current because no tapping are taken from the feeder. The feeder is design according to the current carrying capacity.

Distributor :- A distributor is a conductor from ~~to~~ each tapping are taken ~~to the~~ from supply to the consummer.

Service main :- It is a cable which connect the distributor, to the consummer's energy meter.

Connection



GTD (17) Dt. 3.3.20

HVDC

Advantages :- Important

(1) HVDC transmission has many technical and economical advantages over AC-transmission as followes (1) cheaper in cost :-

→ Bipolar HVDC transmission line require two pole conductor which is very cheap.

→ No skin effect as their is uniform current distribution in dc so, their is no skin effect in HVDC.

Low transmission losses :-

→ HVDC transmission system need only two conductor and there fore the power loss in d.c line is less.

Teacher's Signature..........

EHV (Extra high voltage) Transmission :- 20.02.20 (Ch-5)

-> EHV transmission is define as between 300 kv and 1000 kv (kilo volt).

-> EHV line are used to move large amount of power across long distance.

-> In order to transmit large amount of electric power over long distance extra high voltage transmission line are used, in which lines series inductance and ~~___~~ shunt capacitance influence the performance of line (voltage regulation power flow, stability etc) significantly they can not be neglected it is made up of copper and alluminium.

voltage stability

~~Region of a~~ Reason for adopting EHV transmission losses

Advantage of EHV transmission

1. -> Reduction of electric losses, increase in transmission efficiency improvement of voltage regulation and reduction in conductor material requirement.

(a) line losses are reduced since line losses are inversely proportional to transmission voltage. (~~___~~) (Tv)

(b) Transmission efficiency increased because of reduction in line losses.

(c) voltage regulation is improved because of reduction of percentage (%) line drop.

(d) Lesser conductor material is required being inversely proportional to the square of transmission voltage.

27/2/20

per megawatt per kilometer decreses by the use of EHV A.C. Transmission.

Problem involving in EHV Transmission :-

-> Corona loss and radio interference

The corona loss is not only a source of power loss but it is also a source of interference with radio and television.

-> Corona loss depends on various factor such as system frequency, system voltage, air conductivity, air density, conductor radius, load condition, Atmospheric condition.

-> Corona loss is quait large in EHV transmission line.

(2) Insulation Requirement :-

The level of insulation required depends on the magnitude of likely voltage ~~surch~~ surge due to internal ~~p~~ causes (switching operation) or due to external cost due to lightning, can be protected by the use of ground ware (earthing)

Heavy sporting structure and erection difficulties :-

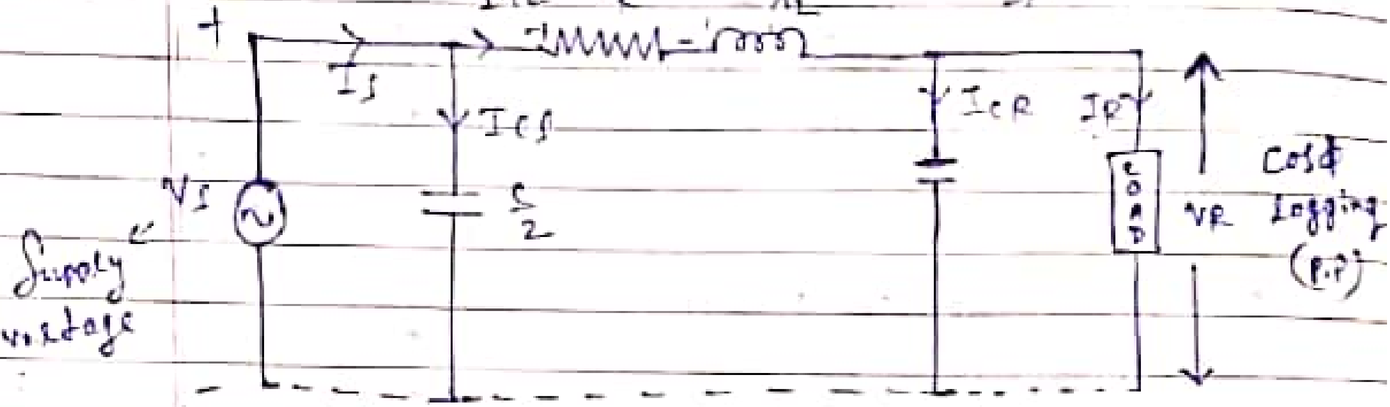
-> Generally EHV A.C Transmission line use bundle conductor which result large mechanical loding on tower, similarly large AR and ground, dynamic ~~for pr~~ forces due to broken conductor etc make large ~~cond~~ mechanical load, hence strength of the tower should be heavy.

Step up transformer ← generating (hydro, nuclear, solar, thermal)

11 kV – 33 kV – 132 kV → voltage drop

20.02.20

GTD Nominal π method :-



$$I_S = I_{CS} + I_{TL} \quad \ldots \text{eq}(1)$$

$$I_{TL} = I_{CR} + I_R \quad \ldots \text{eq}(2)$$

Apply Factor

inductive → J

KVL on the loop

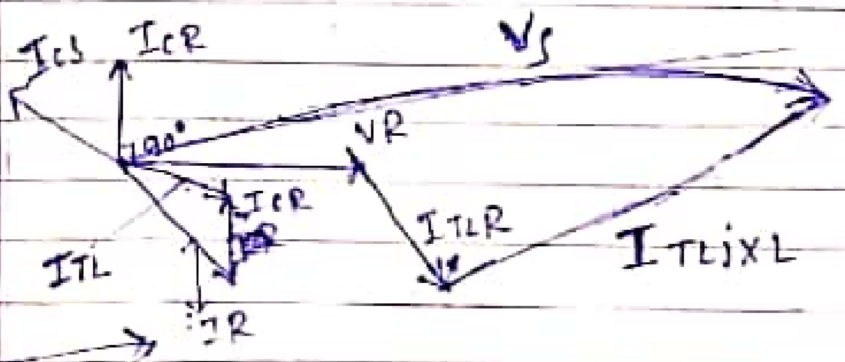
$$-V_S + I_{TL} + R + X_L + V_R = 0$$

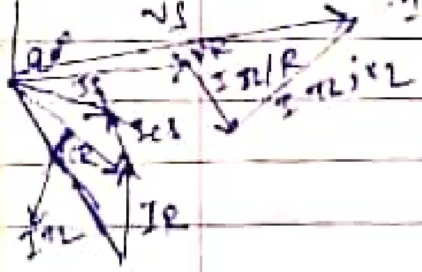
$$-V_S + I_{TL} + R + X_L + V_R = 0$$

$$V_S = I_{TL} + R + X_L + V_R$$

$$\boxed{V_S = V_R + I_{TL} R + I_{TL} j X_L}$$

capacitive





economic cost

surge transmission

long transmission line

R L C

full scale

Known of transmission efficiency.

% Transmission efficiency (η_T)

$$\frac{\text{Receiving end power}}{\text{Sending end power}} \times 100$$

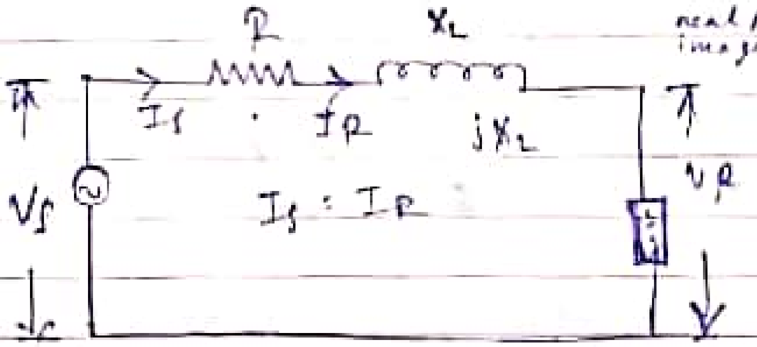
Capacitance (C) → current : lead → 90° lead voltage → lag

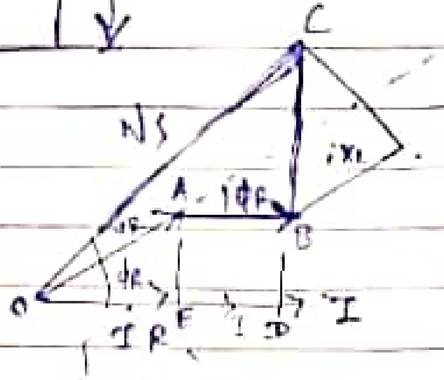
Inductance → (L) → current → lag voltage → lead

→ 90°

$j(X_L - X_C)$ → imaginary(?) → Why it region behind that

real part not same imaginary part same → so, jX_L





$$(OC)^2 = (OD)^2 + (DC)^2$$
$$= (OE + ED)^2 + (DB + BC)^2$$

$$(V_S)^2 = (V_R\cos\phi_R + I_R)^2 + (V_R\sin\phi_R + jX_L)^2$$

$$V_S = \sqrt{(V_R\cos\phi_R + I_R)^2 + (V_R\sin\phi_R + jX_L)^2}$$

$$\cos\phi_S = \frac{OD}{OC}$$
$$= \frac{V_R\cos\phi_R + I_R}{V_S}$$

% η_T =

the support wait of conductor is 1.5 kg for where Base of the tower can be considered to be at water level.

$h = S_2 - S_1 = 90 - 30 = 60$

$S_1 = \frac{w x_1^2}{2T}$; $w = 1600\,kg$ $\quad l = 500$

$= 1600\,kg.$ $\quad x_1 + x_2 = l$

$x_1 + x_2 = 500$

$S_1 = \frac{w x_1^2}{2T}$, $S_2 = \frac{w x_2^2}{2T}$

$S_2 - S_1 = \frac{w x_2^2}{2T} - \frac{w x_1^2}{2T}$

$h = \frac{w}{2T}(x_2^2 - x_1^2)$

$h = \frac{w}{2T}(x_1 + x_2)(x_2 - x_1)$

$60 = \frac{1.5}{2 \times 1600}\, 500\, (x_2 - x_1)$

$x_2 - x_1 = \frac{60 \times 2 \times 1600}{1.5 \times 500} = 256$

$x_2 - x_1 = 256$ $\qquad x_1 - x_2 = 256$

$x_1 + x_2 = 500h$ $\qquad x_1 + x_2 = 500h$

$2x_1 = 244$

$\Rightarrow x_1 = \frac{244}{2} = 122$

(2)

$$x_1 + x_2 = l \quad \text{— (1) eqn (1)}$$

$$S_1 = \frac{w x_1^2}{8T} \qquad S_2 = \frac{w x_2^2}{8T}$$

$$S_2 - S_1 = \frac{w x_2^2}{8T} - \frac{w x_1^2}{8T}$$

$$= \frac{w x_2^2 - x_1^2}{8T} \qquad S = \frac{w l^2}{2T}$$

or $\cancel{S_2 - S_1 = w x_2^2 -}$

$$S_1 = \frac{w x_1^2}{2T} \qquad S_2 = \frac{w x_2^2}{2T}$$

$$S_2 - S_1 = \frac{w x_2^2 - w x_1^2}{2T} \quad \text{or} \quad \frac{w x^2}{2T} - \frac{w x_1^2}{2T}$$

$$= \frac{w(x_2^2 - x_1^2)}{2T} \qquad = \frac{w}{2T}(x_2^2 - x_1^2)$$

$$= \frac{w}{2T}(x_2^2 - x_1^2) \qquad = \frac{w}{2T}(\underbrace{x_2 + x_1}_{l})(x_2 - x_1)$$

$$= \frac{w}{2T}(\underbrace{x_2 + x_1}_{l})(x_2 - x_1) \qquad h = \frac{w}{2T} l (x_2 - x_1)$$

$$h = \frac{w}{2T} l (x_2 - x_1)$$

$$(x_2 - x_1) = \frac{2Th}{wl} \quad \ldots\ldots \text{eqn (2)}$$

eqn 1+2

$$x_2 - x_1 = \frac{2Th}{wl}$$

$$x_1 + x_2 = l$$

$$x_2 - x_1 + x_1 + x_2 = \frac{2Th}{wl} + l$$

$$2x_2 = \frac{2Th}{wl} + l$$

$$x_2 = \frac{Th}{wl} + \frac{l}{2}$$

x_2 put in eq 1 o eqn 2 $= \quad x_1 + x_2 = l \Rightarrow x_1 + \frac{Th}{wl} + \frac{l}{2} = l.$

$$\frac{l}{2} - \frac{Th}{wl} + x_2 = l \qquad x_1 = \frac{l}{2} - \frac{Th}{wl}$$

$$x_1 = l - \frac{l}{2} + \frac{Th}{wl} \Rightarrow$$

In 4 ... performance of standard ... numerical ...

Note: ie ... tangent

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(5)

* The line support used for transmission and distribution of electric power are made in either wood, steel, RCC or lattice steel.

Properties :-

High mechanical strength to with stand the weight of conductor and wind load.

* light in weight.
* long life.
* Chiping in cost.

Wooderen pole :-

Wooderen Pole are made of wood this type of pole are used for Softer distance up to 50 m. They are mainly used in ruller area.

Steel pole :-

Steel pole are used mainly used for distribution perpose in the city area it has high mechanical strength with longer life span. The outer surface of the pole in the Pointed for longer time.

* Rail pole
* Tubular pole
* Rolled steel Joint.

Insulators

- pin type insulator (up to 33kv)
- Suspension (be yond 33kv)
- strain
- shackle

* An electrical insulator is a material whose internal electric charge do not flow freely, very little electric current will flow through it under the influence of an electric field.

* In over head transmission or distribution line insulator are used to insulate the current flowing in the conductor to earth through the pole or tower.

Type of insulator in over head line:-

(1) Pin type
(2) Suspension.
(3). Strain

Two type of insulator are used for low voltage over head line.

(1) Stay type
(2) Shackle type insulator.

Strain insulators:-
In order to relief the line of access tension strain insulator are used.

* For high voltage line strain insulator consist of an assembly of suspension insulator it has high mechanical strength.

Sheckle:-
In early day shackle insulator where used as a strain insulator but now their frequently used for low distribution line

* Used either in horizontal position or vertical position.

* They can directly fixed of the pole with a bolt or to the cross arm.

Stay insulator:-
* This insulator are used on the stay wire is called stay insulator.

(13)

Limitation:-

* It is not easy estimate the energy loss on the line without actual load curve
* This law does not take into account several physical factor like safe current density, Mechanical strength, corona loss etc.
* The conductor size determine by this law may not always be practicable one because it may be too small for the safe carrying of necessary current.

Corona effect: (Most Important)

The phenomenon of violet glow, hissing sound and production of ozone gas in an over head transmission line known a corona.

* It decrease the efficiency of transmission line.

* **Factor affecting corona:-**

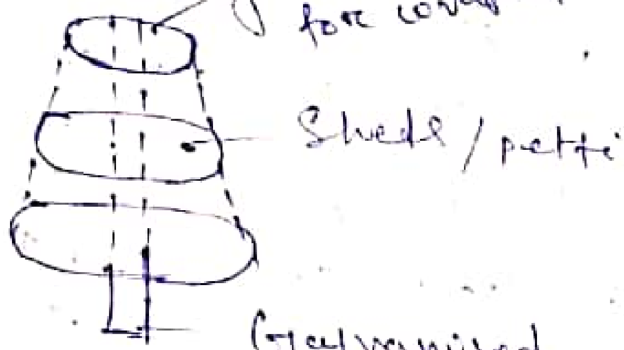
Atmosphere:

As corona is formed due to ionisation of air surrounding the conductor. Air it is affected by the

Pin type insulator:

Popularly used up to 33kV line.

* Pin type insulator is secured to the ~~cr~~ cross arm of the pole.
* Surrounding the insulator body along with electric discharge may take place through air is known as flash over distance.



Suspension type insulator:

Used beyond the voltage 33kV line.
Because pin type is not economical for beyond the voltage of 33kV.

* Number of insulator are connected in series into from a string and line conductor carried by the bottom most insulator.

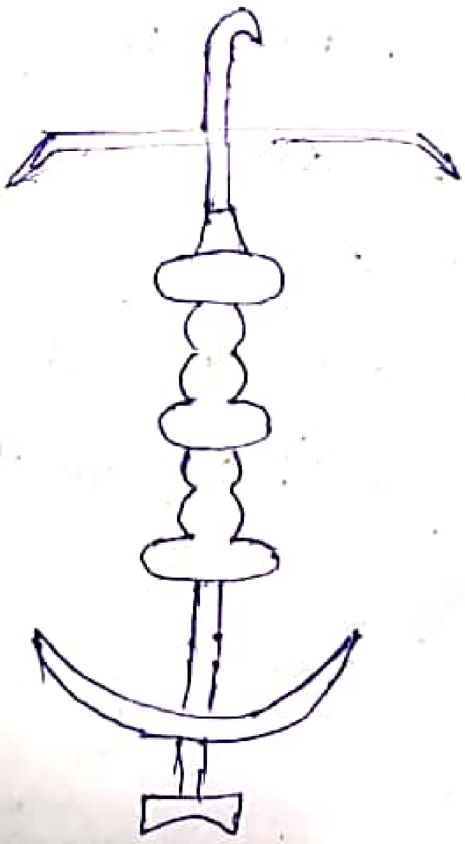
* Each insulator of a suspension spring is called disc insulator because they are disc shape.

* Each disc is ~~degine~~ define for 11 kv.

* In case one disc is demage then it can be removo for repairing.

* If line voltage will increase then that can be insulating by adding more disc in strain.

* This type of insulator it mainly used in steel tower.



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physical state of atmosphere. (7)

Conductor size :-

The rough an irregular surface will give rise to more corona because unevenness of the surface decrease the value of breakdown voltage.

(3) Spacing between conductor :-

(1) If the spacing between conductor is made very large as compaired to the diameter that it may lead to corona.

(4) line voltage :-

If the line voltage increases it may lead to corona, if the line voltage is low the their is no corona.

21.01.2020 :- Chapter-3 :-

line support :

(1) Conductor ——→ Copper / Aluminium → ratio 1:6 / Steel cored. aluminium

(2) line support

(3) Insulator

(4). Cross arm.

Kelvin Law :-

The law state that the most economical area of conductor is that for which the total annual ~~cost~~ cost transmission is minimum.

* Generally annual splited into two part.

(i) Annual charge on capital out lay.
(ii) Annual cost of energy wasted.

Annual charge on $P_1 + P_2 \cdot a$

$$= P_3/a$$

$$C = P_1 + P_2 a + P_3/a$$

$$\frac{d}{da} = \frac{d}{da} P_1 + \frac{d}{da} P_2 a + \frac{d}{da} P_3/a$$

$$\frac{d}{da}\left(P_1 + P_2 a + P_3/a\right) = 0$$

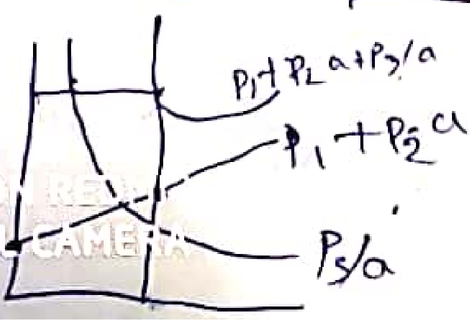
$$0 + P_2 \frac{d}{da} a + P_3 \frac{d}{da}\left(\frac{1}{a}\right) = 0$$

$$P_2 - P_3/a^2 = 0$$

$$\boxed{P_2 = P_3/a^2}$$

Energy waste.

$$\boxed{P_2 a = P_3/a} \rightarrow \text{Maximum cost}$$



Rcc pole :-

6

This pole are very popular in resent day they provide long life span of compair to steel and ~~lead~~ wood pole.

* Greattere mechanical strenght.
* low maintains pole insulator property

Steel tower :-

Long distance transmission and higher voltage steel ~~tower~~ tower is used:

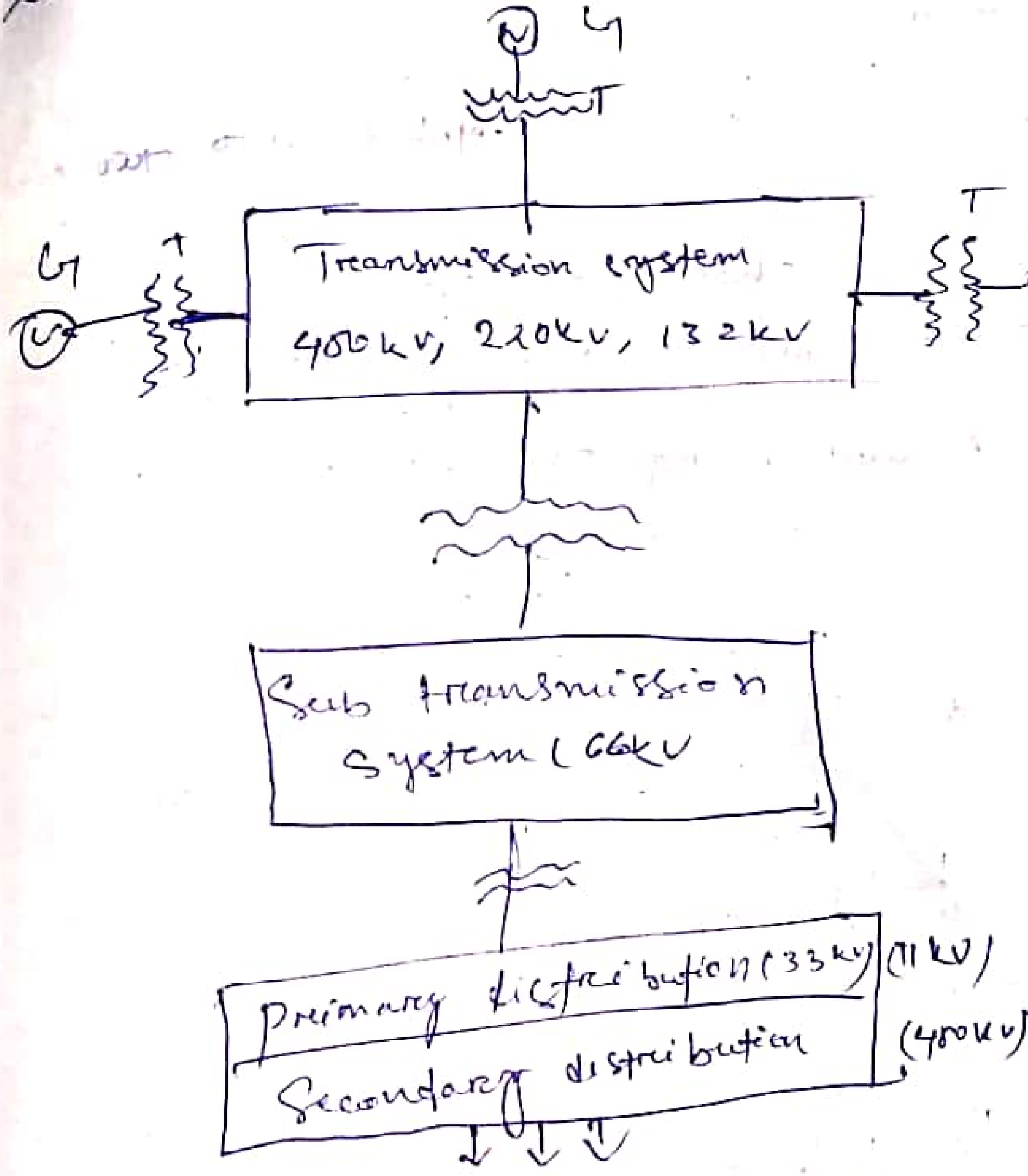
* ~~Gret~~ Gratere life span.
* Greatere mechanical strenght.
* Minimize the lighting trabbel or and each tower act as a lighting a conductor.
* It also use as ckt tower which alloy continuty of supply in case of wall ckt break down.

09.01.2020 :- chapter-2 :-

1

Generation of electricity :-

Transmission of electric power :-



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$$\text{Voltage regulation} = \frac{V_S - V_R}{V_R}$$

$$\text{Voltage regulation percentage} = \frac{V_S - V_R}{V_R} \times 100$$

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Nuclear Reactor -:

→ The Nuclear reactor is the main part of the nuclear power plant. Here a tremendous amount of heat energy is produced by breaking of atoms of uranium or other fission materials by fission process.

Heat Exchanger -:

→ It is like a tube, which is made up aluminium alloy and it has two end.

→ from one end nuclear fission reaction is occur and water is given from the other end.

→ Here water is converted into steam & fed to the steam turbine through steam valve.

* Before that a coolant (sodium metal or gas) carries heat to the heat exchanger where water converts into steam by utilizing the heat of the coolant.

Steam turbine -:

→ The steam turbine converts the ~~steam~~ heat energy into mechanical energy and after doing the useful work, the exhausted steam is allowed to the condenser.

Condenser -:

→ Condenser convert the ~~ste~~ steam from its gaseous state to its liquid state.

feed water pump -:

→ It feed the water from the pump to the heat exchanger.

Alternator -:

→ Here the alternator is coupled with the steam turbine which converts mechanical energy into electrical energy and output of the alternator is fed to the bus-bar through transformer, isolators and circuit braker.

Exciter -:

* used for voltage-regulation.

Teacher's Signature ....

c> Boiler -: The heat of combustion of coal in the boiler is utilised to convert water into steam at high temperature and pressure.

d> Superheater -: The steam produced in the boiler is wet and is passed through a superheater where it (Rises the temp.) is dried and superheated by the flue gases on their way to chimney.

* The superheated steam from the superheater is fed to steam turbine through the main valve.

e> Main valve -: It acts as a regulator which regulate the steam.

f> Economiser -: An economiser increases the pressure of the steam & raising the boiler temp.

g> Air preheater -: An air preheater increases the temp. of the air for coal burning by driving heat from flue gas.

h> Steam Turbine - The dry and superheated steam from the superheater is fed to the steam turbine through main valve.

* The heat energy of steam when passing over the blades of turbine is converted into mechanical energy.

i> Alternator -

* The steam turbine is coupled to an alternator. This alternator converts mechanical energy of turbine into electrical energy.

* The electrical energy then delivered to the bus-bar through transformer, circuit breaker etc.

Advantages -:

1. The cost of the fuel (coal) is cheaper as compared to nuclear power plant.

2. Less quantity of water is required as compared

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to hydro electric power plants.

3. Large amount of power can be generated.

4. Less space is required in comparison with that for hydro electric plants.

Disadvantages -:

1. High maintenance and operating cost.

2. Polluted to the environment.

3. Handling of coal and disposal of ash is quite difficult.

4. Efficiency falls ~~rodi~~ rapidly below 75% of full load.

Isotopes -:

→ Isotopes may be defined as the atoms of an element which have the same atomic number but different atomic masses or mass numbers.

Ex-: Protium ($_1H^1$), deuterium ($_1H^2$) and tritium ($_1H^3$)

* Uranium isotopes used in nuclear power plants are 99.23% of $_{92}U^{238}$, 0.71% of $_{92}U^{235}$ and 0.06% of $_{92}U^{234}$.

Mass energy Relationship -:

* $\boxed{E = mc^2}$ (Einstein's theory)

m = Mass (kilograms)

E = Energy (Joules)

c = Speed of light (3×10^8 m/s)

Nuclear Fission -:

→ The splitting of a heavy nucleus into two or more smaller nuclei is called "Nuclear Fission".

* $U^{235} + n^1 \rightarrow U^{236} \rightarrow La^{148} + Br^{85} + 3n$.

* Uranium^{235} + neutron → Uranium^{236}

Uranium^{236} → Lanthanum^{148} + Bromine^{85} + 3 free neutrons.

Teacher's Signature : ....

Nuclear Fusion -:

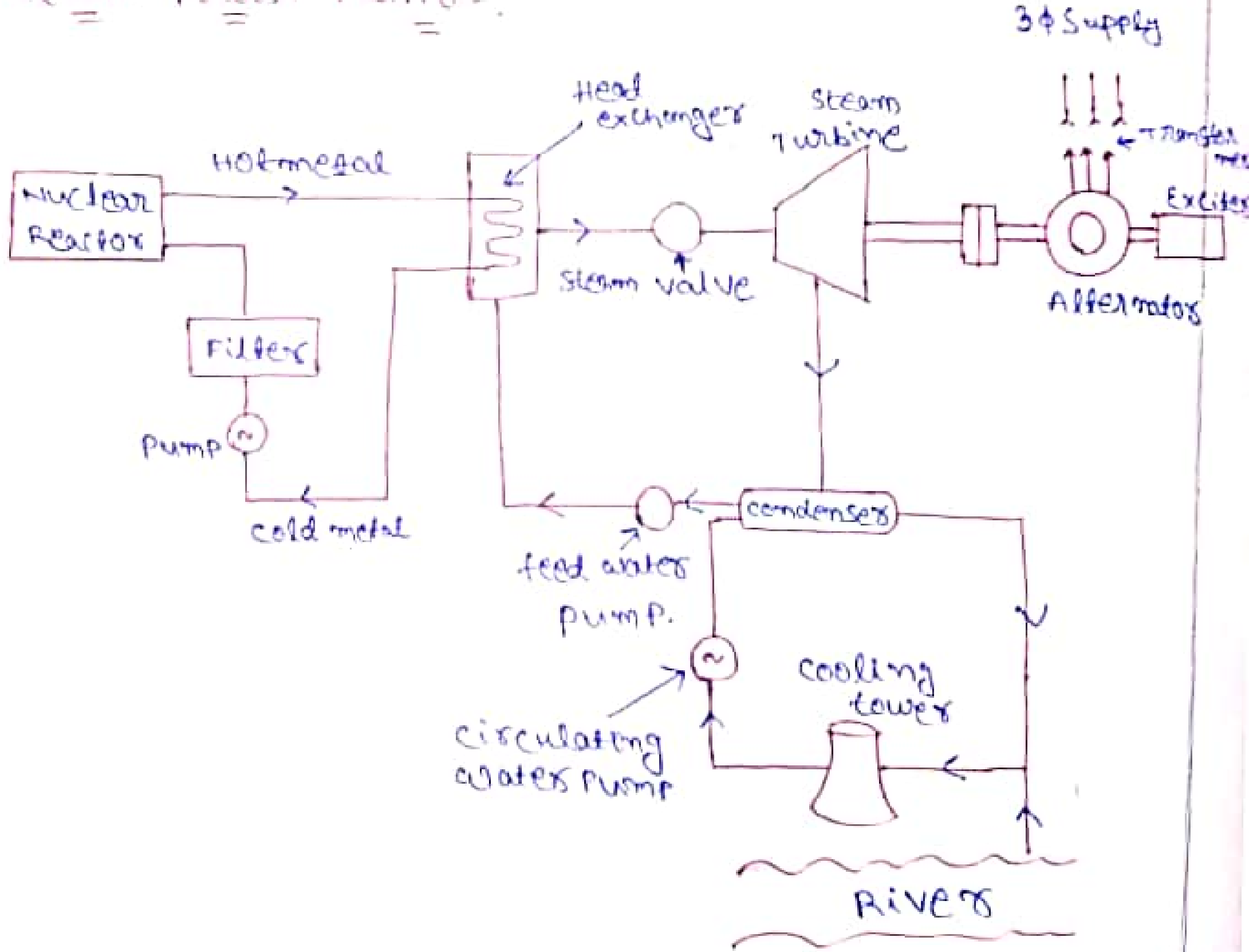
* It is a reaction in which two or more atomic nuclei are combined to form one or more different atomic nuclei and subatomic particles.

Moderator -:

* A material in the reactor core which moderate or reduce the energy & speed of fast moving neutrons without capturing them, and thereby controlling the chain reaction is known as moderator.

Ex -: Heavy water (D_2O), Graphite etc.

Nuclear power plant -:



Date

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* In thermal power plants, coal is used & burned in a boiler chamber.
* As a result of that steam is produce at high pressure and temperature & that steam is given to the steam turbines or some times steam engine.
* This turbine convert the steam pressure into the mechanical energy.
* Here a alternator is coupled with the steam turbine which converts mechanical energy into electrical energy.

Various components in thermal power stations -

a) coal storage -:

→ The coal is transported to the power station by road or railway and is stored in coal storage plant.

b) coal and Ash handling arrangement -:

→ The coal from coal storage plant is delivered to the coal handling plant where it is crushed into small pieces for better burning purpose.

→ This coal then fed to the boiler by belt conveyers.

→ The coal is burnt in the boiler and the ash produced after the complete combustion of coal is removed to the ash handing plant.

→ This ash is delievered to the ash storage plant for disposal.

Steam Generating plant -:

→ The steam generating plant consists of a boiler for the production of steam and other equipment for utilisation of flue gases.

Teacher's Signature :

⑥ Penstock -: It is a large diameter steel pipe connected between valve house and power station.

⑦ Power station -: It is the main part of the hydro electric power station where water energy is converted into electrical energy.

⑧ Spill ways -: The spill ways provides discharge of surplus water (or) flood water from storage reservoir and also serves as a safety valve for the dam.

Advantages -:

a) It's maintenance cost & running cost of the plant is low.

b) It is free from pollution because no smoke and ash are produced in this plant.

c) No fuel transportation problem.

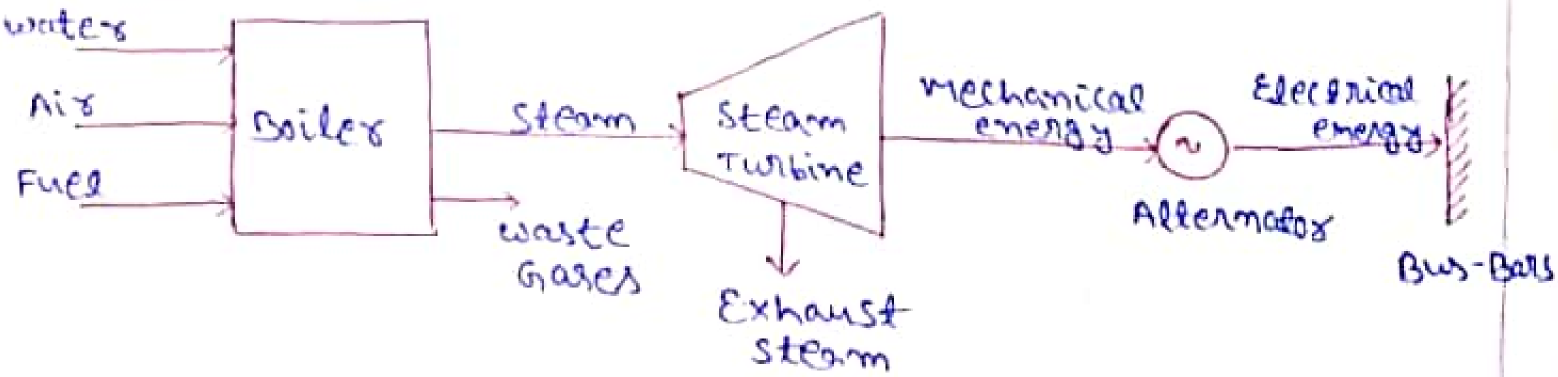
Disadvantages -:

a) Initial cost of the plant including the cost of dam is high.

b) It takes long time for its construction as compared to thermal power plants.

c) More space is required.

Thermal Power plants -:



(Block Diagram)

Date ....

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automatic isolating valves for cutting off water supply in case the penstocks bursts.

* A surge tank is also provided before the valve house for better regulation of water pressure in the system.
* Further, the water is taken out from the valve house to the water turbine through a large diameter pipes, called penstock.
* Here the water turbine converts hydraulic energy in to mechanical energy and the alternator which is coupled on the same shaft of the water turbine will converts mechanical energy in to electrical energy.
* water after doing useful work is discharged to the tail race.

Requirements of Hydro-electric plants -:

1. Catchment Area -: The area behind the dam, which collects the rain water, drains in to a stream (or) river is called "Catchment Area".
2. Reservoir - The place in which the water is stored in a dam is called Reservoir. It may be natural or artifical.
3. Dam - A dam is a structure which is ~~constur~~ constructed across a river or a lake for water storing purpose.
4. Surge tank - A surge tank is a small reservoir or tank in which the water level rises or falls to reduce the water hammerings in side the penstock.
5. Pressure tunnel -: It brings the water from the dam to the valve house.

Teacher's Signature :

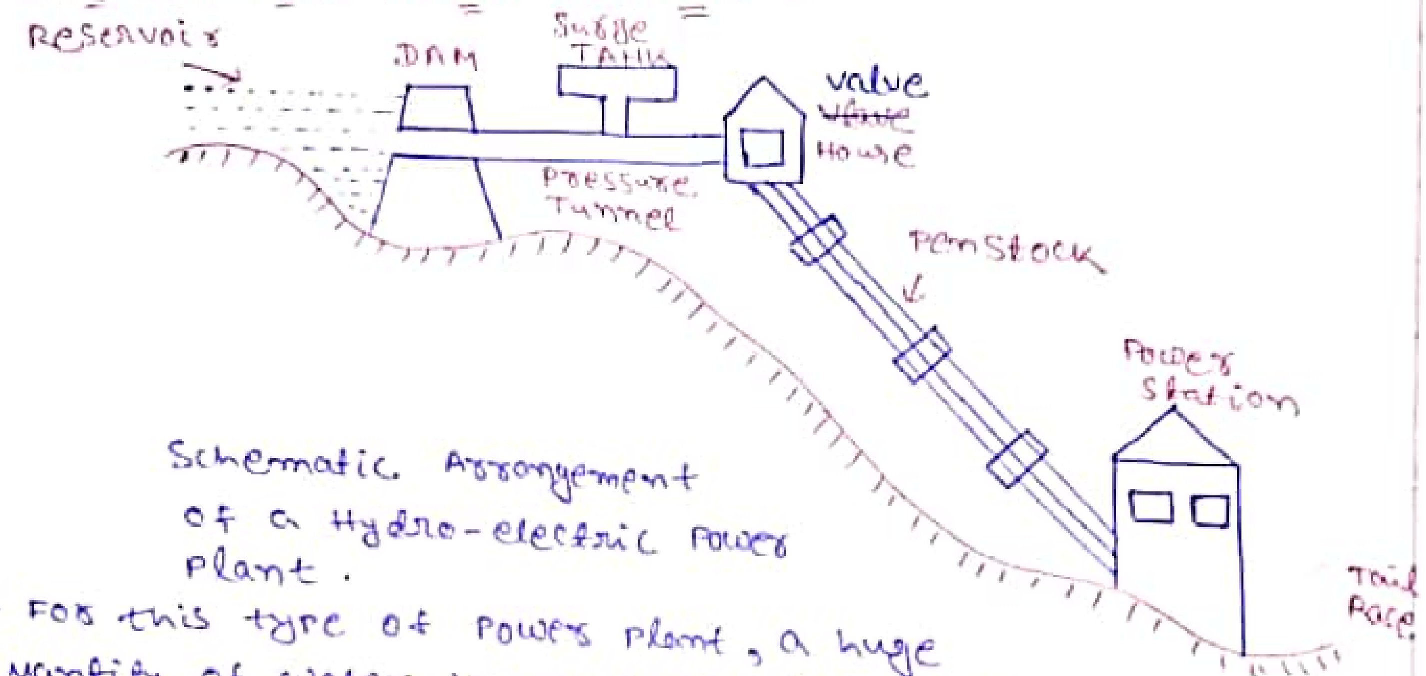
c) Gaseous fuels (Natural gas, petroleum gas etc.)
d) water (Hydro) power.
e) Nuclear power.

Non - conventional sources -: (Renewable energy sources)

* These fuels are producing no net energy.

Ex-: a) The Sun
b) Ocean Tides and waves
c) The wind
d) Fuel cells
e) Biomass / Biogas etc.

Hydro electric power stations -:



Schematic Arrangement of a Hydro-electric Power Plant.

* For this type of power plant, a huge quantity of water is required. Thus, we construct a dam across a river or a lake.

* An artifical storage reservoir is formed by constructing a dam and a pressure tunnel is taken off from the reservoir to the valve house and this water is further provided to the penstock.

* The valve house contains main sluice valves for controlling water flow to the power station and

Sluice -: a sliding gate or other device for controlling the flow of water.

P, Q, R, X - four arm of the wheatstone bridge

In balanced position

$$\frac{P}{Q} = \frac{R}{X}$$

$$\frac{P}{Q} + 1 = \frac{R}{X} + 1$$

$$\frac{P+Q}{Q} = \frac{R+X}{X} \quad \{ R+X = 2r$$

if r is the resistance of each cable

$$\frac{P+Q}{Q} = \frac{2r}{X}$$

$$X = \frac{Q}{P+Q} \times 2r$$

If l = length of each cable in meter

∴ resistance per meter length of cable $= \frac{r}{l}$

∴ distance of fault point from test end : $d = \frac{X}{r/l} = \frac{Q}{P+Q} \times 2r \times \frac{l}{r}$

$$= \frac{Q}{P+Q} \times 2l$$

$d = \frac{Q}{P+Q} \times$ (loop length) in meter

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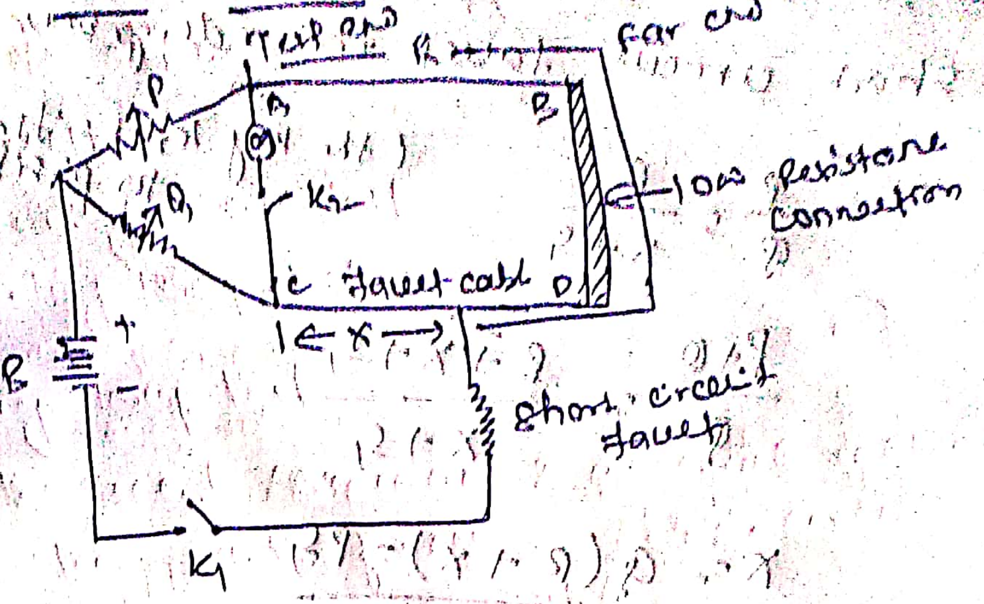
(ii) Short circuit fault



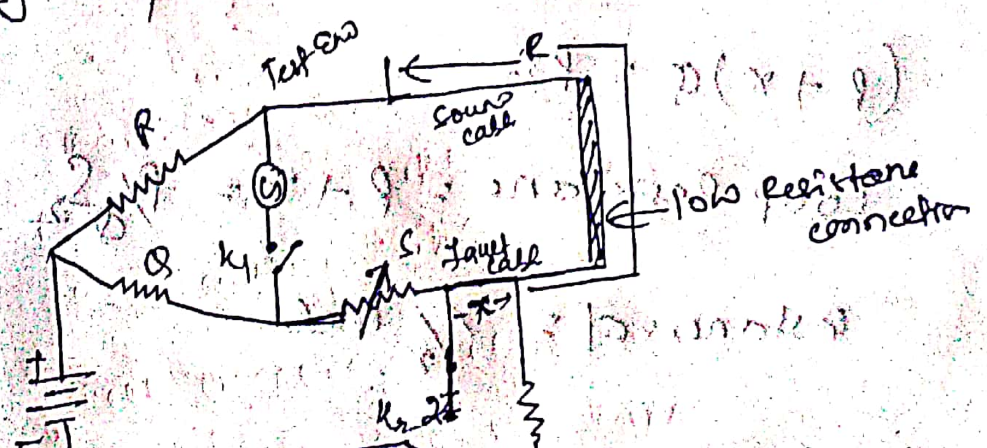
$$\frac{P}{Q} = \frac{R}{X}$$

$$\frac{P+Q}{Q} = \frac{R+X}{X} = \frac{2r}{X}$$

$$X = \frac{Q}{P+Q} \times 2r$$

$$X = \frac{Q}{P+Q} \times (\text{loop length})$$

Varley loop test



→ It is also used to locate earth fault or short circuit fault in underground cable.

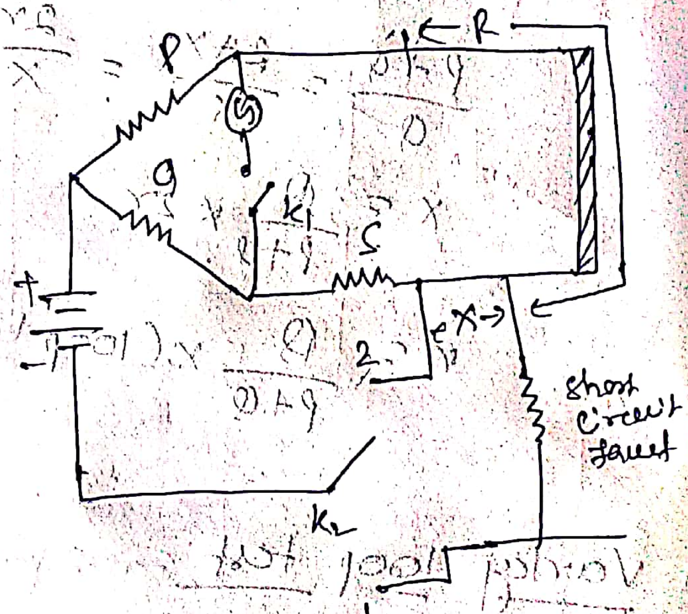
(The key K_2 is first thrown to position 1)

$$\frac{P}{Q} = \frac{R}{X+S_1}$$

$$\frac{P+Q}{Q} = \frac{R+X+S_1}{X+S_1}$$

$$X = \frac{Q(R+X) - PS_1}{P+Q}$$

(for key K_2 is thrown to position 2)



$$\frac{P}{Q} = \frac{R+X}{S_2}$$

$$(R+X)Q = PS_2$$

Loop Resistance $= R + X = \frac{P}{Q} S_2$

Distance $d = X/r$ meter

* Loop test for location of fault in underground cable

Two method

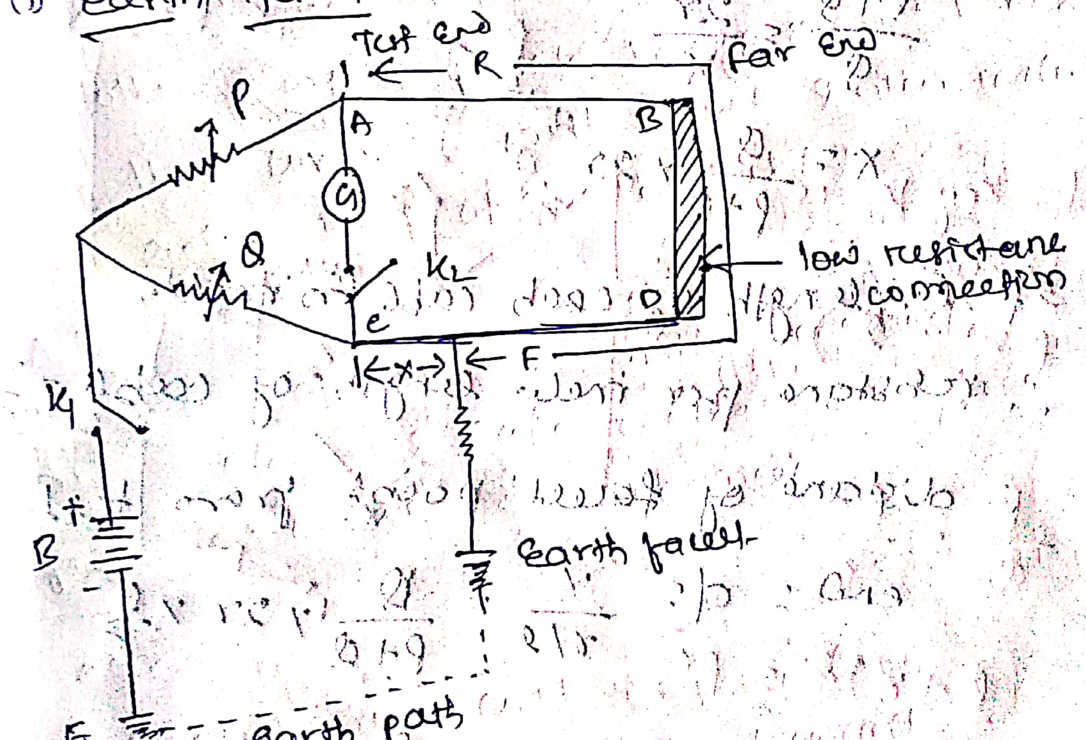
(i) Murray loop test

(ii) Varley loop test

(i) Murray loop test

It is the most common & accurate method of locating earth fault or short-circuit fault in underground cable.

(i) Earth fault



Here AB = sound cable

CD = faulty cable

Earth fault occurring at point F

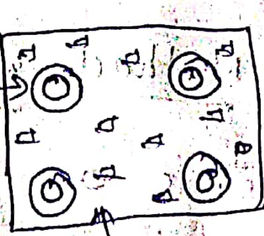
where P, Q are variable resistance.

R = resistance of the conductor loop upto

X = resistance of the test end upto the fault from the test end

X = resistance of other length of the loop

Three of the ducts carry transmission cable & the fourth duct carries relay protection connection.



Adv

→ Repair alternation or additions to the cable n/w can be made with out opening the ground.

Disadv

→ The initial cost is very high.

This method is generally used for short length cable route such as work shops, road crossing.

Solid system

The cable is laid in open pipes or troughs dug out in earth along the cable route. the troughing of cast iron after that cable is laid in position & filled with a bituminous or asphaltic compound then covered over.

Disadv

→ It is more expensive than direct laid system.

→ It requires skilled labour & favourable weather condition.

Method of cable laying

There are three main method of laying underground cable.

(i) Direct laying

→ It is simple & cheap
→ In this method, a trench of about 1.5 meter deep & 45 cm wide is dug, then it is covered with sand bed. After the cable has been laid in trench it is covered with another layer of 10cm thickness. The trench is then covered with brick & other material in order to protect the cable.

Adv
→ It is a simple & less costly method
→ It is clean & safe method and free from external disturbance.

Disadv
→ The maintenance cost is very high
→ localisation of fault is difficult.

Drawn in system

conduit or duct of glazed stone or cast iron or concrete are laid in the ground along with cable route.

→ paper insulated cable have the property to absorb moisture so they are used for cable.

(4) varnished cambric:-

It is cotton cloth impregnated both & coated with varnish called empire tape.

(5) polyvinyl chloride (PVC):-

→ It is obtained from polymerisation of acetylene in the form of white powder

→ High insulation resistance, good dielectric strength & mechanical toughness.

→ This type of insulation is extremely environment cond^n

* classification of cable

It can be classified accordingly

(i) type of insulating material used

(ii) the manufacturing voltage

cable can be divided into

(i) Low tension (L.T) cable - upto 1000 V

(ii) High tension (H.T) cable - upto 11,000 V

(iii) Super tension (S.T) cable - from 22 kV to 33 kV

(iv) Extra high tension (E.H.T) cable - from 33 kV to 66 kV

(v) Extra super voltage cable - beyond 132 kV

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ch-7 underground cable

→ 7.1 It essentially consist of one or more conductor covered with suitable insulation and surrounded by a protecting cover.

Cable insulation

Cable insulation required certain insulation

(1) Rubber :- Pure rubber has reasonably high insulating properties.
→ It absorbs moisture, maximum safe temperature, soft & liable to damage due to rough handling.

(2) VIR :- It is prepared by mixing pure rubber with mineral matter (zinc oxide, red lead) the whole process is called vulcanisation and the product obtained is known as vulcanised indian rubber.
→ having greater mechanical strength, durability.

(3) impregnated paper :- It consist of chemically pulped paper made from wood chippings & impregnated with paraffinic
→ having high dielectric strength, low capacitance, low cost

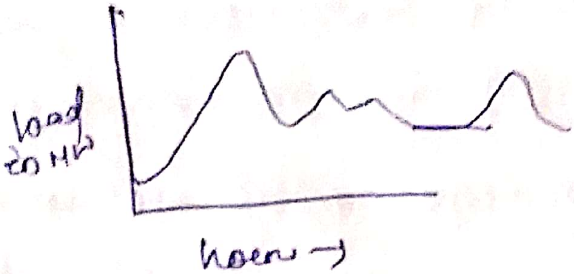
Ch-8

Facts affecting the economics of generation.

(i) Load Curve

The curve showing the variation of load on the power station with respect to time is known as load curve

→ load curve is never constant, it varies from time to time.



(ii) Demand factor

It is the ratio of maximum demand on the power station to its connected load.

$$\text{Demand factor} = \frac{\text{maximum demand}}{\text{connected load}}$$

Note

Connected load - It is the sum of continuous ratings of all the equipments connected to supply system.

max^m demand - It is the greatest demand of load on the power station during a given period.

(iii) **Load Factor**

The ratio of average load to the maximum demand during a given period is known as load factor.

$$\text{load factor} = \frac{\text{Average Load}}{\text{max}^m \text{ demand}}$$

$$= \frac{\text{Average load} \times T\,(\text{hours})}{\text{max}^m \text{ demand} \times T\,(\text{hours})}$$

→ The load factor may be daily load factor, monthly or annual load factor.

→ load factor is always less than 1.

(iv) **Diversity factor**

The ratio of the sum of individual max^m demand to the maximum demand on power station is known as diversity factor.

$$\text{Diversity factor} = \frac{\text{Sum of individual max}^m \text{ demands}}{\text{max}^m \text{ demand on power station}}$$

→ It is always greater than 1.

(v) plant capacity factor

It is the ratio of actual energy produced to the maximum possible energy that could have been produced during a given period.

$$\text{plant capacity factor} = \frac{\text{Actual energy produced}}{\text{max}^{m} \text{ energy that could have been produced.}}$$

$$= \frac{\text{Average demand} \times T}{\text{plant capacity} \times T}$$

$$= \frac{\text{Average demand}}{\text{plant capacity}}$$

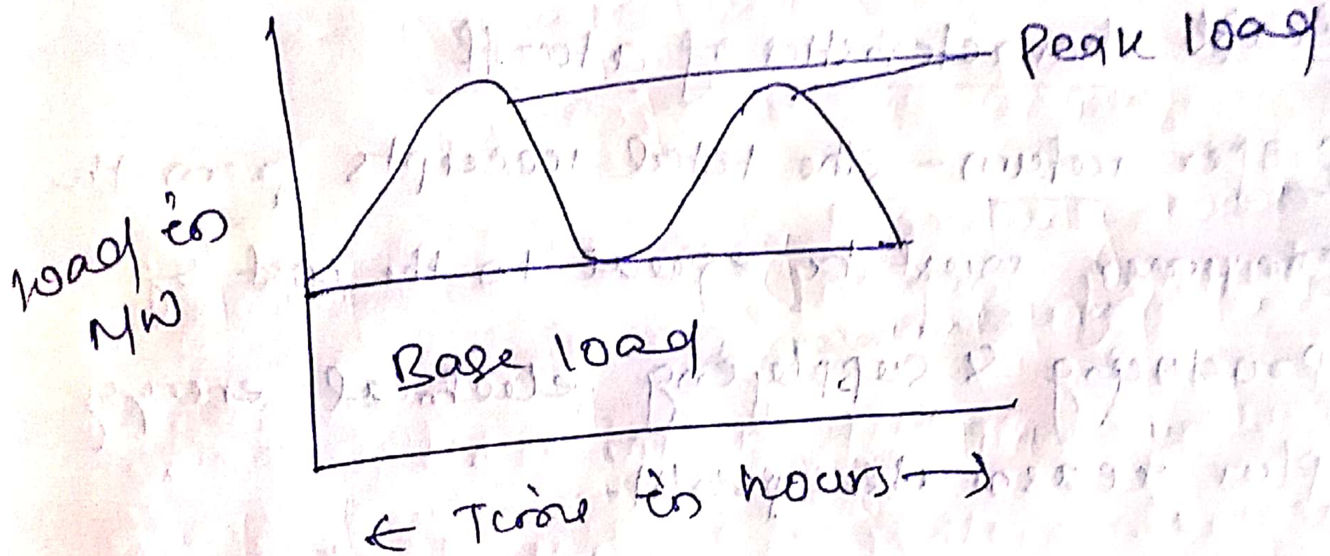
(vi) Base load

The unvarying load which occur almost the whole day on the station is known as base load.

Ex - coal power plant, geothermal power plant, Hydro power plant, nuclear power plant etc.

peak load :- The various peak demands of load over and above the base load of the station is known as peak load.

ex - solar power plant, wind turbine etc



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CH-9

Tariff

The rate at which electrical energy is supplying to a consumer is known as tariff.

tariff = total cost of production + supplying electrical energy + profit

Desirable characteristics of a tariff

(i) **proper return** – The total receipts from the consumer must be equal to the cost of producing & supplying electrical energy plus reasonable profit.

(ii) **fairness!** – The tariff must be fair so that different type of consumer satisfied with the rate of electrical energy.

(iii) **Simplicity!** – The tariff should be simple so that an ordinary person can understand easily.

(iv) **Resonable profit!** – The profit element in the tariff should be resonable.

(v) **Attractive** – The tariff should be attractive so that a large number of consumer are encouraged to use electrical energy.

Type of tariff

(i) Flat rat tariff :- when different type of consumers are charged at different uniform per unit rates it is called a flat rat tariff.

→ the advantage of such a tariff is that it is more fair to consumer & it is quit simple in calculation.

(ii) ~~Block~~ Two ~~rat~~ Part tariff :-

when the rat of electrical energy is charged on the basis of maximum demand of the consumer and the unit consumed it is called a two part tariff

it is of two type

(i) fixed charges → depend upon maximum demand

(ii) running charges → depends upon the number of unit consumed by the consumer.

(iii) Block rat :- when a given block of energy is charged at a specified rate & the succeeding block of energy are charged at progressively reduced rat it is called a block rat tariff

→ the energy consumption is divided into blocks and the prices per unit is fixed in each blocks.

maximum demand tariff :- maximum demand is actually measured by installing maximum demand meter.

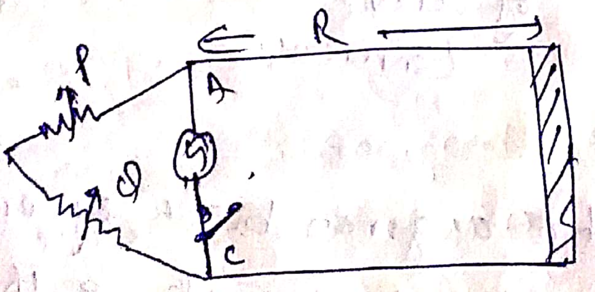
→ this type of tariff is mostly applied to big consumers.

Ex- residential consumer.

Murray loop test-

Murray loop test is the most common & accurate method for earth fault or short circuit fault calculation.

(i) Earth fault :-



Loop test for location of fault in underground cable

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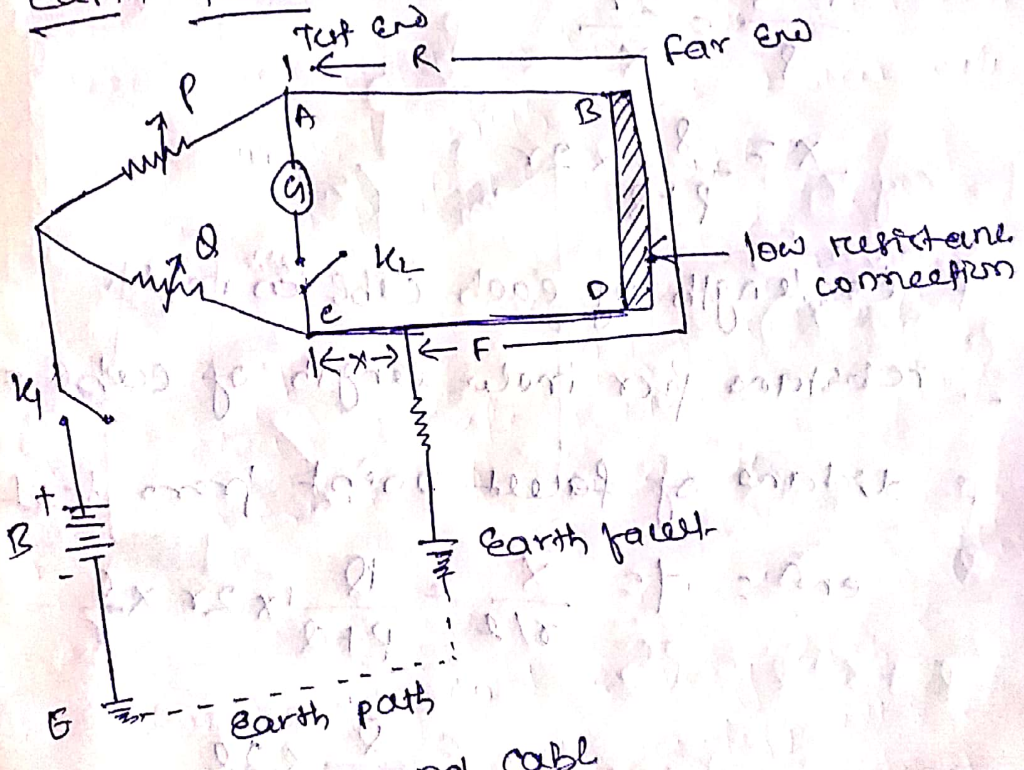

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