# POWER SYSTEM THEORY

1) Why electrical energy is superior to all other forms of energy?
= Answer
i) Convenient form :
Electrical energy can be converted into other forms of energy.
ii) Easy control :
Electrically operated machines have simple and convenient starting, control and operation.
iii) Greater flexibility :
Electrical energy can be easily transported from one place to another with the help of conductors.
iv) Cheapness :
Electrical energy is much cheaper than other forms of energy.
v) Cleanliness :
Electrical energy is not associated with smoke, fumes and poisonous gases.
vi) High transmission efficiency :
Electrical energy can be transmitted from generating station to consumers with the help of a transmission lines.

2) List out the sources of energy available in nature.
= Answer
i) Sun
ii) Wind
iii) Water
iv) Fuel
v) Nuclear energy

3) What are the disadvantages of nuclear power station?
= Answer
i) High cost of nuclear plant.
ii) Problem of radioactive waste and dearth.

4) What do you mean y calorific value of fuels?
= Answer
The amount of heat produced by the complete combustion of a unit weight of fuel is known as its calorific value.

5) Write advantages of liquid fuels over solid fuels.
= Answer
i) Handling of liquid fuels is easier.
ii) Combustion of liquid fuels is uniform.
iii) Firing of liquid fuels can be easily controlled.

6) Write disadvantages of liquid fuels over solid fuels.
= Answer
i) Danger of explosion.
ii) Costlier.

iii) Require special type of burners for burning.

7) Fill up the following statements –
i) The primary source of energy is the _____
ii) The most important form of energy is the _____
iii) The three principal sources of energy used for the generation of electrical energy are _____
iv) The basic unit of energy is _____
= Answer
i) Sun
ii) Electrical energy
iii) Water,fuels and radioactive substances
iv) Joule

8) Fill in the blanks by inserting appropriate words/figure –
i) 1 KWh = _____ Kcal.
ii) The calorific value of a solid fuel is expressed in _____
iii) Electrical energy is _____ than other forms of energy.
iv) The electrical, heat and mechanical energies _____ be expressed in the same unit.
v) _____ continue to enjoy the chief source for the generation of electrical energy.
vi) An alternator is a machine which converts _____ to _____
= Answer
i) 860
ii) Cal/gm or Kcal/Kg.
iii) Cheaper.
iv) can.
v) Fuels.
vi) mechanical energy, electrical energy.

9) What is prime mover?
= Answer
The prime mover converts any energy or steam energy into mechanical energy.

10) What is alternator?
= Answer
An alternator converts mechanical energy into electrical energy.

11) How many types of power generating stations?
= Answer
i) Steam power station.
ii) Hydroelectric power station.
iii) Diesel power station.
iv) Nuclear power station.

12) What is steam power station or thermal station?
= Answer
A generating station which converts heat energy of coal combustion into electrical energy is known as steam power station.

13) Write advantages and disadvantages of steam power station.
= Answer
Advantages : i) Fuel used is quite small.
ii) Less initial cost.
iii) Required less space.
Disadvantages : i) Produced smoke and fumes.
ii) Running cost is costlier.

14) What is boiler?
= Answer
It is used to convert water into steam at high temperature and pressure.

15) What is superheater?
= Answer
It is used to dried steam produced by the boiler.

16) What is economiser?
= Answer
It is used to extracts a part of heat of flue gases to increase the feed water temperature.

17) What do you mean by air-preheater?
= Answer
It is used to increases the temperature of the air supplied for coal burning.

18) What is condenser?
= Answer
The device which condense steam into water is called condenser.

19) Choice of site for steam power station.
= Answer
i) Supply of fuel :
Steam power station should be located near the coal mines.
ii) Availability of water :
As huge amount of water is required for the condenser so steam power station should be located near to river.
iii) Transportation facilities :
Steam power station should be connected to other parts of the country by rail, road or transportation of material and machinery.
iv) Nearness to load centres :
Steam power station should be located near the centre of the load.

20) Efficiency of steam power station is low-why?
= Answer
The overall efficiency of a steam power station is quite low about 29%.Due to a huge amount of heat lost in the condenser and heat losses occur at various stages of the plant.

21) What is thermal efficiency of steam power station?
= Answer

It is the ratio of heat equivalent of mechanical energy transmitted to turbine shaft to the heat of coal combustion.

Thermal efficiency of a modern steam power station is about 30%.

22) What is overall efficiency of steam power station?
= Answer
It is the ratio of heat equivalent of electrical output to the heat of combustion of coal.

Overall efficiency of a steam power station is about 29%.

23) How many types of boiler?
= Answer
i) Water tube boiler :

In a water tube boiler, water flows through the tubes and the hot gases of combustion flow over these tubes.
ii) Fire tube boiler :

In a fire tube boiler, hot gases of combustion flows through the tubes surrounded by water.

24) Write advantages of water tube boilers over fire tube boilers?
= Answer
i) Less space
ii) High working pressure.
iii) Less liable to explosion.

25) What is the material used for boiler furnace walls?
= Answer
Fire clay, silica, kaolin as it has the property to resist change of shape, weight and physical properties at high temperature.

26) What is economizer?
= Answer
It is a device which heats the feed water on its way to boiler by deriving heat from the flue gases.

27) What is primemover?
= Answer
The prime mover converts steam energy into mechanical energy.

28) What is impulse turbine?
= Answer
In an impulse turbine,the steam expands completely in the stationary nozzles or fixed blades,the pressure over the moving blades remain constant.

29) What is reaction turbine?
= Answer
In a reaction turbine,the steam is partially expanded in the stationary nozzles or fixed blades,the remaining expansion takes place over the moving blades.

30) What is switchgear?

= Answer
It detects fault on the system and isolate the faulty part of the system.It contains circuit breakers,relays,switches and other control devices.

31) What do you mean by hydroelectric power station?
= Answer
A generating station which utilises the potential energy of water at a high level for the generation of electrical energy is known as a hydroelectric power station.

32) What are the advantages and disadvantages of hydroelectric power station?
= Answer
Advantages : (i) It requires no fuel.
(ii) It is quite neat and clean.
Disadvantages : (i) It involves high capital cost.
(ii) There is uncertainity about the availability of huge amount of water.

33) What is penstock?
= Answer
A steel or concrete pipe by which water is taken to water turbine is known as penstock.

34) What is governor?
= Answer
The governor opens or closes the turbine gates in accordance with changes in electrical load.

35) Choice of site for hydroelectric power station.
= Answer
i) Availability of water :
It should be located at a place where water is available.
ii) Storage of water :
It should provide adequate facilities for erecting a dam and storage of water.
iii) Cost and type of land :
It should be available at a reasonable price in which construction is made.
iv) Transportation facilities :
It should be connected to the other parts of the country by rail,road for transportation of material and machinery.

36) Write uses of impulse and reaction turbines.
= Answer
Impulse turbine : It is used for high heads (pelton wheel).
Reaction turbine : It is used for low and medium heads (Kaplan and Francis turbines).

37) What is diesel power station?
= Answer
A generating station in which diesel engine is used as the prime mover for the generation of electrical energy is known as diesel power station.It is used in hospitals,radio stations,cinema houses and telephone exchanges.

38) What are the advantages and disadvantages of diesel power station?

= Answer
Advantages : (i) It can be located at any place.
(ii) The overall cost is much less.
Disadvantages : (i) The fuel used is costly.
(ii) Generate small power.

39) What is nuclear power station?
= Answer
A generating station in which nuclear energy is converted into electrical energy is known as a nuclear power station.
Elements used in nuclear power station are Uranium ($U^{235}$) or Thorium ($Th^{232}$).

40) what is fission?
= Answer
The breaking up of nuclei of heavy atoms into two nearly equal parts which release of huge amount of energy is known as nuclear fission.

41) What are the advantages and disadvantages of nuclear power station.
= Answer
Advantages : (i) The amount of fuel required is quite small.
(ii) A nuclear power plant requires less space.
Disadvantages : (i) High cost of nuclear plant.
(ii) Problem of disposal of radioactive waste and dearth.

42) Selection of site for nuclear power station.
(i) Availability of water :
It should be located at a place where huge amount of water is available as water is required for cooling purposes.
(ii) Disposal of waste :
It should have adequate arrangement for the disposal of radioactive waste.
(iii) Distance from populated areas :
It should be quite away from the populated areas as there is a danger of presence of radioactivity in the atmosphere.
(iv) Transportation facilities :
It should be connected to the other parts of the country by rail,road for transportation of material and machinery.

43) What is gas turbine plant?
= Answer
A generating station in which gas turbines is used as the primemover for the generation of electrical energy is known as gas turbine power plant.

44) What are the advantages and disadvantages of gas turbine plant?
Advantages : (i) Simplest.
(ii) Less maintenance.
Disadvantages : (i) Problem of starting the unit.
(ii) Overall efficiency is low about 20%.

45) What is compressor?
= Answer
The device which removes dust from the air and compress air is called compressor.

46) What is regenerator?
= Answer
A device which recovers heat from the exhaust gases of the turbine is called regenerator.

47) What is electric power system?
= Answer
The function of an electric power system is to connect the power station to the consumer's load by means of interconnected system of transmission and distribution networks.Power system consists of the power station,the transmission lines and the distribution system.

48) What is transmission lines?
= Answer
Connecting link between the power station and the distribution lines.

49) Shows a single line diagram of a electric power system.
= Answer

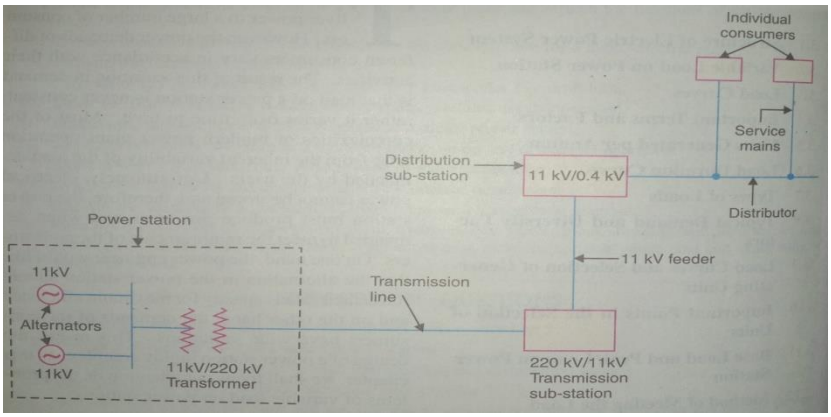



Fig. Single line diagram of a electric power system

50) What do you mean by variable load on the station?
= Answer
The load on a power station varies from time to time due to uncertain demands of the consumer and is known as variable load on the station.

51) What is load curve?
= Answer
The variation of load on the power station with respect to time is known as load curve.

52) What important information can be made from the daily load curve?
= Answer
(i) Maximum load on the station during the whole day.
(ii) Size of generating units to be installed.
(iii) Operating schedule of the station.

53) What is base load and peak load?
= Answer
The unvarying load which occurs almost the whole day on the station is known as base load.
The various peak demand of load over and above the base load of the station is known as peak load.

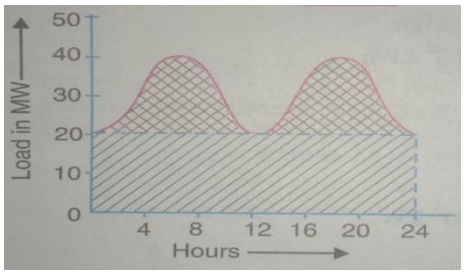



Fig. Base load and Peak load

54) Explain the following terms –
i) Connected load
ii) Maximum demand
iii) Demand factor
iv) Average load
v) Load factor
vi) Diversity factor
vii) Plant capacity factor
= Answer
i) It is the sum of continuous ratings of all the equipments connected to the supply system.
ii) It is the greatest demand of load on the power station during a given period.
iii) It is the ratio of maximum demand on the power station to its connected load.
iv) The average load occurring on the power station in a given period is known as average load or average demand or it is the product of maximum demand and load factor.
v) The ratio of average load to the maximum demand during a given period is known as load factor.
vi) The ratio of the sum of individual maximum demands to the maximum demands on the power station is known as diversity factor.
vii) It is the ratio of actual energy produced to the maximum possible energy that could have been produced during a given period.

55) What is the demand factor kept in an industry?
= Answer
0.60
Demand factor decreases with increasing H.P. ratings
0-10 H.P. – 0.75
10-20 H.P. – 0.65
20-100 H.P. – 0.55
Over 100 H.P. – 0.50

56) How many types of load?
= Answer
i) Domestic load :
Lights,fans,refrigerators,heaters,television and motors for pumping water.

ii) Commercial load :

Loghts,fans,refrigerators,heaters,television and motors for pumping water but these are used for more hours during the day.

iii) Industrial load :

Small scale industry requires load upto 25 KW,medium scale industry 25 KW-100 KW and large scale industry requires load above 500 KW.

iv) Municipal load :

Street lighting,water supply and drainage purposes.

v) Irrigation load :

It is used for pumps driven by motors to supply water to fields.

vi) Traction load :

Trum cars,trolley buses,railways.

57) What is interconnected grid system?

= Answer

The connection of several generating stations in parallel is known as interconnected grid system.

58) Fill in the blanks –

i) The major heat loss occur in a steam power station occurs in _____

ii) The thermal efficiency of a steam power station is about _____

iii) Cooling towers are used where _____

iv) The running cost of medium power station is about _____ paise per unit.

v) In a hydroelectric plant,spillways are used _____

vi) The running cost of a hydroelectric plant is about _____ paise per unit.

vii) For high head hydroelectric plant,the turbine used is _____

viii) Francis and Kaplan turbines are used for _____ heads.

ix) Surge tank is provided for the protection of _____

x) Of all plants,minimum quantiuty of fuel s required in _____plant.

xi) The cost of fuel transportation is minimum in _____ plant.

xii) The cheapest plant in operation and maintenance is _____ plant.

xiii) Economisers are used to heat _____

xiv) The running cost of a nuclear power plant is about _____ paise per unit.

xv) Diesel power plant are used as _____ plants.

xvi) India’s first nuclear power plant was built at _____

xvii) The most simple and clean plant is _____ plant.

xviii) Draft tube is used in _____ turbines.

= Answer

i) Condenser about 53%

ii) 28%

iii) Water is not available at sufficient quantity.

iv) 15

v) to discharge surplus water on the down stream side of dam.

vi) 5

vii) pelton wheel

viii) medium and low

ix) Penstock

x) nuclear power

xi) Hydroelectric

xii) hydroelectric
xiii) feed water
xiv) 20
xv) standby
xvi) Tarapur
xvii) hydroelectric
xviii) reaction

59) Fill in the blanks –
i) The area under the daily load curve gives _____
ii) The connected load is generally _____ than the maximum demand.
iii) The value of demand factor is _____ than 1.
iv) The higher the load factor of a power station,the _____ is the cost per unit generated.
v) The value of diversity factor is _____ than 1.
vi) The lesser the diversity factor,the _____ is the cost of generation of power.
vii) Base load occurs on the power station or _____ hours in a day.
viii) The knowledge of diversity factor helps in determining _____
ix) More efficient plants are used as _____
x) Installed capacity of a power station is _____ than the maximum demand.
= Answer
i) Units generated in the day
ii) more
iii) less
iv) lesser
v) more
vi) greater
vii) 24
viii) plant capacity
ix) base load stations
x) more

60) What is economics of power generation?
= Answer
The art of determining the per unit i.e. one KWh cost of production of electrical energy is known as economics of power generation.

61) What do you mean by tariff?
= Answer
The rate at which electrical energy is supplied to a consumer is known as tariff.

62) How many types of tariff?
= Answer
i) Simple tariff :
When there is a fixed rate per unit of energy consumed,it is called a simple tariff or uniform rate tariff.
ii) Flat rate tariff :
When difference types of consumers are charged at different uniform per unit rates,it is called a flat rate tariff.

iii) Block rate tariff :

When a given block of energy is charged at a specified rate and the succeeding blocks of energy are charged at progressively reduced rates,it is called a block rate tariff.

iv) Two part tariff :

When the rate of electrical energy is charged on the basis of maximum demand of the consumer and the units consumed,it is called a two part tariff.

v) Maximum demand tariff :

When the rate of electrical energy is charged on the basis of maximum demand of the consumer and the units consumed,it is called a maximum demand tariff.

vi) Power factor tariff :

The tariff in which power factor of the consumer's load is taken into consideration is known as power factor tariff.

vii) Three part tariff :

When the total charge to be made from the consumer is split into three parts Viz. fixed charge,semi fixed charge and running charge,it is known as a three part tariff.

63) What happened if the power factor of an a.c. circuit be decreased?

= Answer

Low power factor causes an increase in current,resulting losses of active power in all the elements of power system.As P = $V_L I_L cos\emptyset$ i.e. $I_L = \frac{P}{V_L cos\emptyset}$ therefore when cosØ decreases $I_L$ increases.

64) What do you mean by power factor?

= Answer

The cosine of angle between voltage and current in an a.c. circuit is known as power factor.

65) What are the disadvantages of low power factor?

= Answer

i) Large KVA rating of equipment :

Since,KVA = $\frac{KW}{cos\emptyset}$ when cosØ decreases KVA rating of the machine is increased.Due to this,making the machine larger which is expensive.

ii) Greater conductor size :

Since,I = $\frac{P}{Vcos\emptyset}$ when cosØ decreases I increases.So at constant voltage to carry large current the conductor size should be taken larger.

iii) Larger copper loss :

Since,I = $\frac{P}{Vcos\emptyset}$ when cosØ decreases I increases so $I^2R$ loss increases.

iv) Poor voltage regulation :

Since, I = $\frac{P}{Vcos\emptyset}$ when cosØ decreases I increases so voltage drops in alternators,transformers,transmission lines and distribution lines also increases.It makes decreased voltage at the supply end .So voltage regulation decreases.

v) Reduced handling capacity of system :

Lagging power factor reduces the handling capacity of all the elements of the system.

66) How can you improve power factor?

= Answer

Static capacitor :

The power factor can be improved by connecting capacitors in parallel with the system.

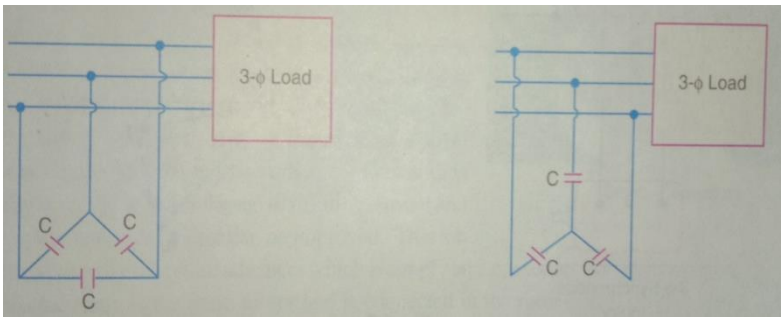
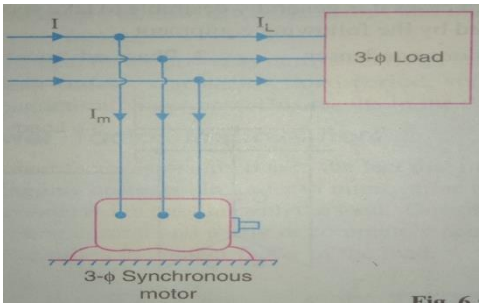



Fig. Capacitor connected in delta or star in three-phase load

Synchronous condenser :

An over excited synchronous motor running on no load is connected in parallel with the system.




Phase advancer :

The phase advancer which is simply an a.c. exciter is mounted on the same shaft as the main motor and is connected in the rotor circuit of the motor whose power factor is to be improved.

67) Fill in the blanks

i) The lagging power factor is due to _____ power drawn by the circuit.

ii) Power factor can be improved by installing such a device in parallel with load which takes _____

iii) The major reason for low lagging power factor of supply system is due to the use of _____ motors.

iv) An over excited synchronous motor on no load is known as _____

v) The maximum value of power factor can be _____

vi) KVAR = _____ tanØ.

vii) By improving the power factor of the system,the KW delivered by the generating station are _____

viii) The most economical power factor for a consumer is generally _____

= Answer

i) lagging reactive power

ii) leading reactive power

iii) induction

iv) Synchronous condenser

v) 1

vi) Kw

vii) increased

viii) 0.95 lagging

68) What do you mean by electric supply system?
= Answer
The conveyance (carry) of electric power from a power station to consumer's premises (houses) is known as electric supply system.It consists of three components Viz. the power station,the transmission lines and the distribution system.

69) What are advantages and disadvantages of a.c. and d.c. transmission system?
= Answer
AC transmission :
Advantages :
i) It can be generated at high voltages.
ii) Maintenance of a.c. substation is easy and cheaper.
iii) It can be stepped up or stepped down by transformer with easy and efficiency.
Disadvantages :
i) There is skin effect.
ii) There is corona loss.
iii) There is inductance,capacitance,phase displacement and surge problems.
DC transmission :
Advantages :
i) Requires two conductors.
ii) No skin effect.
iii) No corona loss.
iv) No inductance,capacitance,phase displacement and surge problems.
Disadvantages :
i) It cannot be generated at high dc voltage due to commutation problems.
ii) It cannot be steeped up.

70) How transmission efficiency increases with high transmission voltage?
= Answer
We know that,

$$\text{Transmission efficiency} = \frac{Output\ power}{Input\ power}$$
$$= \frac{P}{P(1+\frac{\sqrt{3}\rho jl}{V cos\emptyset})}$$
$$= \frac{1}{1+\sqrt{3}\frac{\rho jl}{V cos\emptyset}}$$
$$\simeq 1 - \sqrt{3}\frac{\rho jl}{V cos\emptyset}$$

Where,
P = Power
$\rho$ = Resistivity of the conductor
l = Length of the conductor
j = Current density
V = Voltage
Cos$\emptyset$ = P.f. of the load
As $\rho$,j and l constant so transmission efficiency increases when V increases.

71) What do you mean by constants of an overhead transmission line?
= Answer

Resistance,inductance and capacitance.

72) Give a statement about elements of a transmission line.
= Answer
i) Conductors :
It carry currents.
ii) Step-up and step-down transformers :
It step-up or step-down current.
iii) Line insulators :
It support the line conductors and isolate them electrically from the ground.
iv) Support :
It is usually steel tower and support to the conductors.
v) Protective devices :
It consists of ground wires,lightning arrestors,circuit breakers and relays etc.
vi) Voltage regulating devices :
It is used to main voltage at the receiving end.

73) Fill up the following statement –
i) In India _____ system is adopted for transmission of electric power.
ii) _____ voltage is used for power transmission as a matter of economy.
iii) The distribution system comprises of three elements Viz. _____
iv) DC transmission is _____ to ac transmission.
v) The higher transmission voltage,the _____ is the conductor material required.
vi) The choice of proper transmission voltage is essentially a question of _____
vii) In overhead system,the comparison of various syatem is made on the basis of maximum voltage between _____
viii) The economic size of conductor is determined by _____
ix) In a transmission system,the cost of conductor is proportional to _____ of conductor.
x) The economic transmission voltage is one for which the transmission cost is _____
xi) The greater the power to be transmitted,the _____ is the economic transmission voltage.
xii) The economic transmission voltage _____ the distance of transmission.
= Answer
i) 3-phase,3-wire
ii) High
iii) feeders,distributors,service mains.
iv) superior
v) lesser
vi) economics
vii) conductor and earth
viii) Kelvin's law
ix) area
x) minimum
xi) lesser
xii) depends upon

74) Write properties of conductor material.
= Answer
i) High electrical conductivity.

ii) High tensile strength.
iii) Low cost.
iv) Low specific gravity.

75) What are the material used for conductor?
= Answer
i) Copper
ii) Aluminium
iii) Steel-cored aluminium
iv) Galvanised steel
v) Cadmium copper

76) How many types of insulators?
= Answer
i) Pin type insulator (Upto 33 KV)
ii) Suspension type insulator (Above 33 KV)
iii) Strain insulator (Below 11 KV)
iv) Shackle insulator (Below 11 KV)

77) What is string efficiency?
= Answer
The ratio of voltage across the whole string to the product of number of discs and the voltage across the disc nearest to the conductor is known as string efficiency.

String efficiency = $\frac{Voltage\ across\ the\ string}{n \times Voltage\ across\ disc\ nearest\ to\ conductor}$

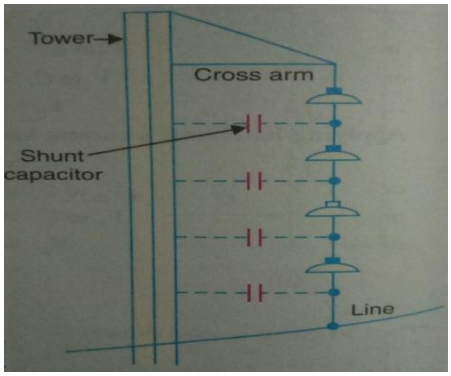
Where,

n = Number of disc in the string.

The greater the string efficiency,the more uniform is the voltage distribution.

78) Explain – methods of improving string efficiency.
= Answer
i) By using longer cross arm :

The value of string efficiency depends upon the value of K i.e. the ratio of shunt capacitance to mutual capacitance.The lesser the value of K,the greater is the string efficiency and more uniform is the voltage distribution.The value of K can be reduced by reducing the shunt capacitance.In order to reduce shunt capacitance,the distance of conductor from tower must be increased i.e. longer cross arm should be used.In practice K = 0.1 can be achieved by this method.

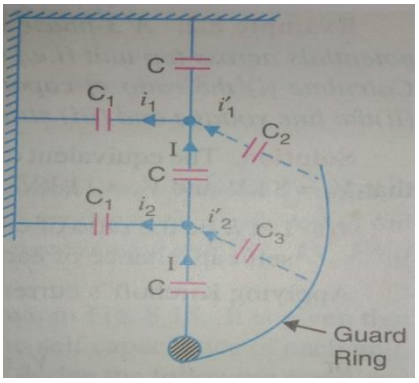


ii) By grading the insulators :

The insulators are capacitance graded i.e. they are assembled in the string in such a way that the top unit has the minimum capacitance increasing progressively as the bottom unit is reached.Since voltage is inversely proportional to capacitance,this method trends to equalise the potential distribution across the units in the string.

iii) By using guard ring :

The potential across each unit in a string can be equalised by using a guard ring which is a metal ring electrically connected to the conductor and surrounding the bottom insulator.The guard ring introduces guard ring contoured in such a way that shunt capacitance currents are equal to metal fitting line capacitance currents.The result is that same charging current flows through each unit of string consequently,there will be uniform potential distribution across the units.




79) What is corona?

= Answer

The phenomenon of violet glow,hissing noise and production of ozone gas in an overhead transmission line is known as corona.

80) How corona formed?

= Answer

Some ionization is always present in air therefore,under normal condition,the air around the conductors contains some onised particles and neutral molecules.When p.d. is applied between the conductors,potential gradient is set up in the air which will have maximum value at the conductor surfaces.

When the potential gradient at the conductor surface reaches about 30 Kv per cm the velocity acquired by the free enough force to dislodge more electron from it.

Thus the process of ionization is commulative.The result of this ionization corona is formed.

81) State-factors affecting corona.

= Answer

i) Atmosphere :

Corona is formed due to ionization of air surrounding the conductors.

ii) Conductor size :

Corona effect depends upon the shape and conditions of the conductors.

iii) Spacing between conductors :

To reduce corona effect spacing between the conductors is made large as compared to their diameter.

iv) Line voltage :

Corona effect depends upon the line voltage.

82) What is critical disruptive voltage?
= Answer
It is the minimum phase neutral oltage at which corona occurs.
Potential gradient at the conductor surface,

$$g = \frac{V}{rlog_e\frac{d}{r}} \text{ V/cm}$$

Where,
V = Phase-neutral potential.
r = Radii of the two conductors.
d = Spacing between conductors.

Corona is formed when breakdown strength of air at 76 cm pressure and temperature of $25^0c$ is 30Kv/cm.

$$g_0 = \frac{V_c}{rlog_e\frac{d}{r}}$$

$$\therefore V_c = g_0\, rlog_e\frac{d}{r}$$

Again,
$g_0 \propto$ Air density

$\therefore V_c = g_0\delta\, rlog_e\frac{d}{r}$ [$\delta$ = Air density factor ]

= m$g_0\delta\, rlog_e\frac{d}{r}$ [ $m_0$ = Irregularity factor ]

$m_0$ = 1 for polished conductors
= 0.98 to 0.92 for dirty conductors
= 0.87 to 0.8 for stranded conductors

83) What is visual critical voltage?
= Answer
It is the minimum phase-neutral voltage at which corona glow appears all along the line conductors.

$V_v = m_v g_0\delta\, r(1+\frac{0.3}{\sqrt{\delta\, r}})\, log_e\frac{d}{r}$ Kv/Phase

84) Write the expression for power loss due to corona.
= Answer

P = $242.2(\frac{f+25}{\delta})\sqrt{\frac{r}{d}}$ (V-$V_c$) $\times 10^{-5}$Kw/Km/Phase

Where,
f = supply frequency (Hz)
V = phase-neutral voltage (r.m.s.)
$V_c$ = disruptive voltage (r.m.s.) per phase.

85) Write advantages and disadvantages of corona.
= Answer
Advantages :
(i) Due to corona virtual diameter of the conductor is increased so it reduces the electrostatic stresses between the conductors.
(ii) Due to corona transients produced by surges reduced.
Disadvantages :

(i) Energy loss.
(ii) Ozone is produced.
(iii) Current is non-sinusoidal.

86) State-methods of reducing corona effect.
= Answer
i) By increasing conductor size :
By increasing conductor size,the voltage at which corona occurs is raised and hence corona effects are reduced.Examples is ACSR.
ii) By increasing conductor spacing :
By increasing the spacing between the conductor,the voltage at which corona ccurs is raised and hence corona effects can be eliminated.

87) What is sag?
= Answer
Te difference in level between points of support and the lowest point on the conductor is called sag.

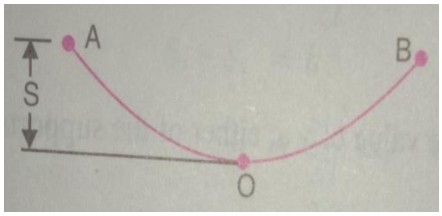
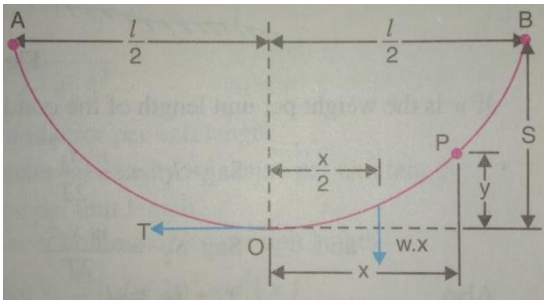



Fig. Sag

88) Calculate sag when supports are at equal levels.
= Answer




Assume,
l = Length of span
w = Weight per unit length of conductor
T = Tension in the conductor
At point 'o',

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

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

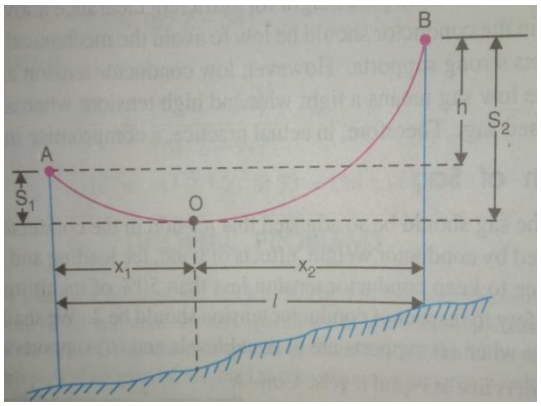
Maximum dip or sag is occur either point A or B.

$$x = \frac{l}{2}, y = S$$

$$\therefore S = \frac{w(\frac{l}{2})^2}{2T}$$

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

89) Calculate sag when supports are at unequal levels.
= Answer




Assume,

l = Span length
h = Difference in levels between two supports.
$x_1$ = Distance of support at lower level from o.
$x_2$ = Distance of support at hogher level from o.
T = Tension in the conductor.

$S_1 = \frac{wx_1^2}{2T}$

$S_1 = \frac{wx_2^2}{2T}$

Again,

$x_1+x_2$ = l -------- (i)

Now,

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

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

$= \frac{wl}{2T}(x_2-x_1)$ [Since, $x_1+x_2$ = l]

Again,

$S_2-S_1$ = h

$\therefore \frac{wl}{2T}(x_2-x_1)$ = h

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

=>l - $x_1$ - $x_1$ = $\frac{2Th}{wl}$ [From (i)]

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

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

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

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

From (i),

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

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

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

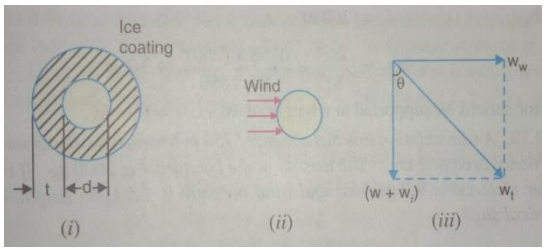
$S_1 = \frac{w}{2T}(\frac{l}{2} - \frac{Th}{wl})^2$

$S_2 = \frac{w}{2T}(\frac{l}{2} + \frac{Th}{wl})^2$

90) State effect of wind and ice loading on conductor.

= Answer

The weight of ice acts vertically downwards i.e. in the same direction as the weight of conductor.The force due to the wind is to act horizontally.




$w_t = \sqrt{(w + w_i)^2 + (w_w)^2}$

w = weight of conductor per unit length

= conductor material density×volume per unit length

$w_i$ = weight of ice per unit length

= density of ice×volume of ice per unit length

= density of ice× $\frac{\pi}{4}\{(d + 2t)^2 - d^2\} \times 1$

= density of ice× $\pi t\{(d + t) \times 1\}$

$w_w$ = wind pressure per unit length

= wind pressure per unit area×projected area per unit length

= wind pressure×{(d+2t)×1}

Conductor makes an angle $\theta$ to the vertical,

$\tan\theta = \frac{w_w}{w+w_i}$

slant sag,

$S = \frac{w+l^2}{2T}$

Vertical sag = $S\cos\theta$

$= S\cos\{tan^{-1}(\frac{w_w}{w+w_i})\}$

91) Fill up the following statement

i) Cross-arms are used on poles or towers to provide _____ to the insulators.

ii) The most commonly used material for insulators of overhead line is _____

iii) The potential across various discs of suspension string is different because of _____ capacitance.

iv) In a string of suspension insulators,the maximum voltage appears across the unit _____ to the conductor.

v) If the string efficiency is 100%,it means that _____

vi) If shunt capacitance is reduced,then string efficiency is _____

vii) If the spacing between the conductors is increased,then corona effect is _____

viii) If sag in an overhead line increases,tension in the line _____

ix) By using a guard ring,string efficiency is _____
x) Shunt capacitance in suspension insulators can be decreased by increasing the distance of _____ from _____
xi) The insulation is so designed that it should fail only by _____
xii) Suspension type insulators are used for voltage beyond _____
xiii) In a string suspension insulators,if the unit nearest to the conductor breaks down,then other units will _____
xiv) A shorter string has _____ string efficiency than a larger one.
xv) Corona effect is _____ pronounced in stormy weather as compared to fair weather.
xvi) If the conductor size is increased,the corona effect is _____
xvii) The longer the cross arm,the _____ the string efficiency.
xviii) The disc of the strain insulators are used in _____ plane.
xix) Sag is provided in overhead line so that _____
xx) When an insulator breaks down by puncture,it is _____ damaged.
= Answer
i) support
ii) porcelain
iii) shunt
iv) nearest
v) potential across each disc is the same
vi) increased
vii) reduced
viii) decreases
ix) increased
x) conductor,tower
xi) flash-over
xii) 33 Kv
xiii) also breakdown
xiv) more
xv) more
xvi) decreased
xvii) greater
xviii) vertical
xix) safe tension is not exceeded
xx) permanently

92) What do you mean by charging current of an overhead transmission line?
= Answer
In an overhead transmission line conductors are separated by air which acts as an insulation,therefor,capacitance exists,between any two overhead line conductors.When an alternating voltage is impressed on a transmission line,a current flows between the conductors which is known as charging current.This charging current flows in the line even when it is open circuited i.e. supplying no-load.

93) What is skin effect?
= Answer
The tendency of alternating current to concentrate near the surface of a conductor is known as skin effect.

94) What are the factors effecting skin effect?
= Answer
i) Nature of material.
ii) Diameter of wire (increases with the increase of diameter of wire)
iii) Frequency (increases with the increase of frequency)
iv) Shape of wire (less for stranded conductors than the solid conductor)

95) State Ampere's law.
= Answer
M.M.F. (ampere-turns) around any closed path equals the current enclosed by that path.

96) Write the full name of G.M.R.;S-GMD;M-GMD.
= Answer
G.M.R. = Geometric mean radious
S-GMD = Self geometrical mean distance
M-GMD = Mutual geometrical mean distance

97) Fill up the following statements
i) The power loss in an overhead transmission line is mainly due to _____
ii) If the length of a transmission line increases,it's inductance is _____
iii) The d.c. resistance of a line conductor is _____ than it's a.c. resistance.
iv) If capacitance between two conductors of a 3-phase line 4 $\mu$F,then capacitance of each conductor to neutral is _____
v) If the length of the line is decreased,it's capacitance is _____
vi) Transposition of a 3-phase transmission line helps,in _____
vii) A neutral plane is one where _____ is zero.
viii) In a single phase overhead line,the neutral plane lies at _____
ix) If the supply frequency increases,then skin effect is _____
x) An overhead transmission line has appreciable inductance because loop it forms has _____ cross sectional area.
xi) If the spacing between the conductors is increased,the inductance of the line _____
xii) The skin effect is _____ for stranded conductor than the solid conductor.
xiii) If the conductor diameter decreases,inductance of the line is _____
= Answer
i) Line conductor resistance
ii) increased
iii) less
iv) 8 $\mu$F
v) decreased
vi) equalizing inductance and capacitance of the three phases.
vii) electric intensity
viii) the centre of the distance between the conductors.
ix) increased
x) large
xi) increases
xii) less
xiii) increased (Z= $\rho \frac{l}{A}$)

98) Why skin effect absent in the d.c. system?
= Answer
For a direct current,inductance is zero and hence skin effect is not occur in the d.c. system.

99) Describe-classification of overhead transmission line.
= Answer
i) Short transmission line :
When the length of an overhead transmission line is upto about 50 km and the line voltage is less than 20 kv,it is known as short transmission line.
ii) Medium transmission line :
When the length of an overhead transmission line is about 50-150 km and the line voltage is greater than 20 kv and less than 100 kv it is known as medium transmission line.
iii) Long transmission line :
When the length of an overhead transmission line is greater than 150 km and the line voltage is greater than 100 kv it is known as long transmission line.

100) What is voltage regulation of transmission line?
= Answer
The difference in voltage at the receiving end of a transmission line between conditions of no load and full load is called voltage regulation.

$$\text{Percentage voltage regulation} = \frac{V_S - V_R}{V_R} \times 100$$
$$= \left(\frac{V_S}{V_R} - 1\right) \times 100$$

Where,
$V_S$ = Sending end voltage
$V_R$ = Receiving end voltage

101) What is transmission efficiency?
= Answer
The ratio of receiving end power to the sending end power of a transmission line is known as transmission efficiency.
Percentage transmission efficiency,

$$\eta_T = \frac{Receiving\ end\ power}{Sending\ end\ power} \times 100$$
$$= \frac{V_R I_R \cos\emptyset_R}{V_S I_S \cos\emptyset_S} \times 100$$

102) Fill up the following statements
i) In short transmission lines,the effects of _____ are neglected.
ii) _____ of transmission lines,is the most important cause of power loss in the line.
iii) In the analysis of 3-phase transmission line,only _____ is considered.
iv) For a given $V_R$ and $I_R$,the regulation of the line _____ with the decrease in p.f. for lagging loads.
v) If the p.f. of the load decreases,the lines losses _____
vi) In medium transmission lines,effects of _____ are taken into account.
vii) The rigorous solution of transmission lines takes into account the _____ nature of line constants.
viii) In any transmission line,AD – BC = _____
ix) In a transmission line,generalized constants _____ and _____ are equal.
x) The dimensions of constants B and C are respectively _____ and _____
xi) The line constants of a transmission lines are _____

xii) The length of a short transmission line is upto about _____
xiii) The capacitance of a transmission line is a _____ element.
xiv) It is disarable that voltage regulation of a transmission should _____
xv) When the regulation is positive,the receiving voltage is _____ than sending end.
xvi) The shunt admittance of a transmission line is 3-micro siemens.It's complex notation will be _____ siemen.
xvii) The exact solution of any transmission line must consider the fact that line constants are _____
xviii) The generalized constants A and D of the transmission line have _____
xix) $3<10^0 \times 60<20^0$ = _____
xx) $\sqrt{9 < 90^0 \times 4 < 10^0}$ = _____
= Answer
i) Capacitance
ii) resistance
iii) one phase
iv) increases ($V_R I_R cos\emptyset_R$ = P)
v) increase
vi) capacitance
vii) distributed
viii) 1
ix) A and D
x) ohm,siemen
xi) uniformly distributed
xii) 50km
xiii) shunt
xiv) low
xv) less
xvi) $3\times 10^{-6} < 90^0$
xvii) uniformly distributed
xviii) no dimensions
xix) $180<30^0$
xx) $6<50^0$

103) Describe the construction of underground cables.
= Answer
Cores :

A cable may have one or more than one core depending upon the types of service for which it is intended.The conductors are made up of alluminium.

Insulation :

Each core is provided with a suitable thickness of insulation.The commonly used materials for insulation are paper,varnished cambric.

Metallic sheath :

In order to protect the cable from moisture,gases and atmosphere a metallic sheath of alluminium is provided.

Bedding :

Over the metallic sheath is applied a layer of bedding which consists of a fibrous material like jute or hessian tape.The purpose of bedding is to protect the metallic sheath against corrosion.

Anmouring :

Over the bedding anmouring is provided which consists of one or two layers of galvanised steel wire.As purpose is to protect the cable from mechanical injury.

Serving :

In order to protect anmouring from atmospheric conditions a layer of fibrous material similar to brdding is provided over the anmouring.

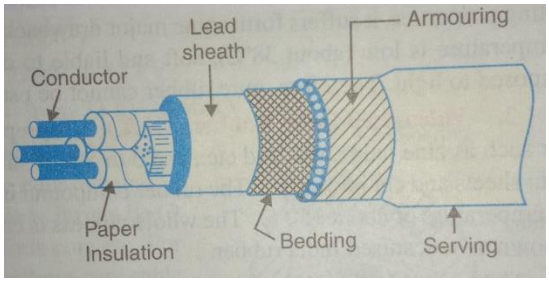



Fig. Construction of a Cable

104) State properties of insulating materials.
= Answer
i) High insulation resistance.
ii) High dielectric strength.
iii) High mechanical strength.
iv) Non-hygroscopic.
v) Non-inflammable.
vi) Low cost.
vii) Uneffected by acids and alkalies.

105) State classification of cables.
= Answer
i) Low tension cables – upto 1000 V
ii) High tension cables – upto 11000 V
iii) Super tension cables – 22 kV to 33 kV
iv) Extra high tension cables – 33 kV to 66 kV
v) Extra super voltage cables – beyond 132 kV

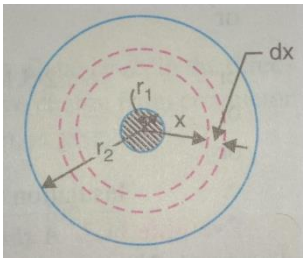
106) State classification of cables for 3-phase service.
= Answer
i) Belted cables – upto 11 kV
ii) Screened cables – 22 kV to 66 kV
   a) H-type cables
   b) S.L. (separate lead) type cables
iii) Pressure cables – beyond 66 kV
   a) Oil-filled cables
   b) Gas pressure cables

107) What is the insulation resistance of the cable?
= Answer
The opposition offered by insulation to leakage current is known as insulation resistance of the cable.

Let,a single core cable of conductor radious $r_1$ and internal sheath radious $r_2$.l be the length of the cable and $\rho$ be the resistivity of the insulation.

Consider a very small layer of insulation of thickness dx at a radious x.The length through which leakage current tends to flow is dx and the area of cross section offered to this flow is $2\pi$xl.

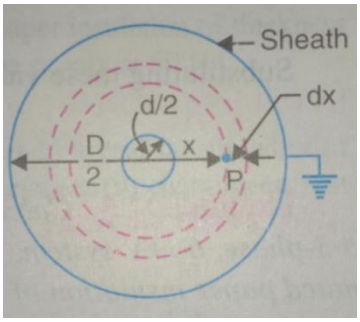
$\therefore$Insulation resistance of considered layer $= \rho.\frac{dx}{2\pi xl}$




Insulation resistance of the whole cable is,

$$R = \int_{r_1}^{r_2} \rho \frac{dx}{2\pi xl}$$
$$= \frac{\rho}{2\pi l}\int_{r_1}^{r_2} \frac{dx}{x}$$
$$= \frac{\rho}{2\pi l}\log_e \frac{r_2}{r_1}$$

108) Give expression for capacitance of a single core cable.
= Answer




Let,us consider a single core cable with conductor diameter 'd' and inner sheath diameter 'D'.
Let,the charge per metre axial length of the cable be 'Q' coulombs and 'ε' be the permittivity of the insulation material between core and lead sheath.

$\therefore \varepsilon = \varepsilon_0 \varepsilon_r$

Where,$\varepsilon_r$ = Relative permittivity

Let,us consider a cylinder of radious x metres and axial length 1 metre.

$\therefore$Surface area of this cylinder is = 2πx×1 $m^2$

= 2πx $m^2$

Again,Electric flux density at point 'P'

$$D_x = \frac{Charge}{Unit\ area}$$
$$= \frac{Q}{2\pi x}\ C/m^2$$

Electric intensity at point 'P',

$$E_x = \frac{D_x}{\varepsilon}$$
$$= \frac{Q}{2\pi x \varepsilon}$$

$$= \frac{Q}{2\pi x \varepsilon_0 \varepsilon_r} \text{ Volts/m}$$

Workdone in moving a unit positive charge from conductor to sheath which is the potential difference 'V' between conductor and sheath,

$$V = \int_{d/2}^{D/2} E_x dx$$
$$= \int_{d/2}^{D/2} \frac{Q}{2\pi\, \varepsilon_0 \varepsilon_r} dx$$
$$= \frac{Q}{2\pi\, \varepsilon_0 \varepsilon_r} \log_e \frac{D}{d}$$

Capacitance,

$$C = \frac{Q}{V}$$
$$= \frac{Q}{\frac{Q}{2\pi\, \varepsilon_0 \varepsilon_r} \log_e \frac{D}{d}}$$
$$= \frac{2\pi \varepsilon_0 \varepsilon_r}{\log_e (\frac{D}{d})} \text{ F/m}$$
$$= \frac{2\pi \times 8.854 \times 10^{-12} \times \varepsilon_r}{2.303 \log_{10} (\frac{D}{d})}$$
$$= \frac{\varepsilon_r}{41.4 \log_{10} (\frac{D}{d})} \times 10^{-9} \text{ F/m}$$

If the cable has l metres,

$$C = \frac{\varepsilon_r l}{41.4 \log_{10} (\frac{D}{d})} \times 10^{-9} \text{ F}$$

109) Show that ratio of $\frac{g_{max}}{g_{min}} = \frac{D}{d}$ where d = diameter of single core cable and D = diameter of the intersheath.

= Answer

Consider a single core cable with core diameter d and internal sheath diameter D.

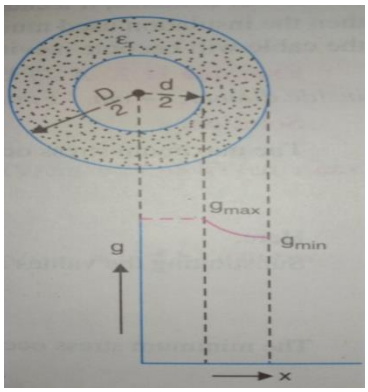
The electric intensity at a point x metres from the centre of cable is given by,

$$E_x = \frac{q}{2\pi \varepsilon_0 \varepsilon_r x} \text{Volts/m}$$

Where,

Q = charge

We know that electric intensity is equal to potential gradient 'g' at a point x metre from the centre of the cable.




$$g = E_x$$
$$\therefore g = \frac{q}{2\pi \varepsilon_0 \varepsilon_r x} \text{ -------- (i)}$$

Again,potential difference between conductor and sheath is,

$$V = \frac{Q}{2\pi\,\varepsilon_0\varepsilon_r}\log_e\frac{D}{d}\ \text{Volts}$$

$$\therefore Q = \frac{2\pi\varepsilon_0\varepsilon_r V}{\log_e\frac{D}{d}} \text{ --------- (ii)}$$

Comparing (i) and (ii) –

$$g = \frac{2\pi\varepsilon_0\varepsilon_r V}{\log_e\frac{D}{d}} \times \frac{1}{2\pi\varepsilon_0\varepsilon_r x}$$

$$\therefore g = \frac{V}{x\log_e\frac{D}{d}}$$

∴Potential gradient is inversely proportional to x.

$$\therefore g_{max} = \frac{V}{\frac{d}{2}\log_e\frac{D}{d}}$$

$$= \frac{2V}{d\log_e D/d} \text{ -------- (iii)}$$

$$g_{min} = \frac{V}{\frac{D}{2}\log_e\frac{D}{d}}$$

$$= \frac{2V}{D\log_e D/d} \text{ -------- (iv)}$$

Dividing (iii) by (iv) we get,

$$\frac{g_{max}}{g_{min}} = \frac{D}{d}$$

110) What doyou mean by grading of cables?Classified it.

= Answer

The process of achieving uniform electrostatic stress in the dielectric of cables is known as grading of cables.

Capacitance grading :

The process of achieving uniformity in the dielectric stress by using layers of different dielectric is known as capacitance grading.

Intersheath grading :

The process of achieving uniformity in the dielectric stress by using homogeneous dielectric which is divided into various layers by replacing metallic intersheath between the core and lead sheath is known as intersheath grading.

111) What do you mean by thermal resistance?

= Answer

It is the ratio of temperature difference between two points divided by the heat flowing between them in a unit time.

$$S = \frac{Temperature\ difference}{Heat\ flowing\ in\ a\ unit\ time}$$

$$= \frac{Temperature\ rise\ (t)}{Watts\ dissipated\ (P)} \text{ [In S.I. unit]}$$

$$= \frac{t}{P}$$

Again, $S \propto \frac{l}{A}$

$$\therefore S = k.\frac{l}{A}$$

Where, k = Thermal resistivity (Constant)

l = Length

A = Cross sectional area

112) State – thermal resistance of dielectric of a single core cable.

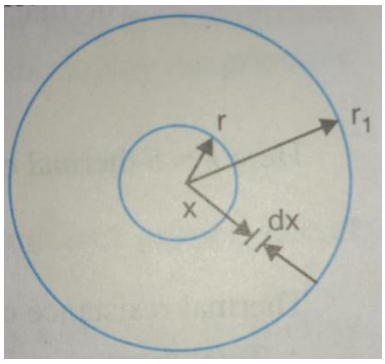
= Answer

Let, r = radious of the core

$r_1$ = radious of the sheath

K = Thermal resistivity of the insulation i.e. dielectric

dS = k×$\frac{dx}{2\pi x}$




Thermal resistance of the dielectric is,

$$\int dS = \int_r^{r_1} k \times \frac{dx}{2\pi x}$$

$$=> S = \frac{k}{2\pi} \log_e \frac{r_1}{r}$$

$$\therefore S = \frac{k}{2\pi} \log_e \frac{r_1}{r}$$

113) Explain cable faults.

= Answer

i) Open circuit fault :

When there is a break in the conductor of a cable,it is called open circuit fault.The open circuit fault can be checked by a megger.

The three conductor of the 3-core cable at the far end are shorted and earthed.The resistance between each conductor and earth is measured by a megger.The megger will indicate zero resistance when it is not broken and it will indicate infinite resistance when it is broken.

ii) Short circuit fault :

When two conductors of a multi core cable come in electrical contact with each other due to insulation failure,it is called a short circuit fault.

The two terminals of the megger are connected to any two conductors.If the megger gives zero reading,it indicates short circuit fault.

iii) Earth fault :

When the conductor of a cable comes in contact with earth,it is called earth fault or ground fault.

The one terminal of the megger is connected to the conductor and the other terminal connected to earth.If the megger gives zero reading,it means that conductor is earthed.

114) Explain – loop tests for location of faults in underground cables.

= Answer

i) Murray loop test.

ii) Varley loop test.

115) Fill in the blanks

i) The underground system is _____ costly that the equivalent overhead line system.

ii) Voltage drop in cable system is less than that of equivalent overhead line because of _____ of conductors in a cable.
Iii) A metallic sheath is provided over the insulation to protect the cable from _____ .
iv) In single core cables,anmouring is not done in order to avoid _____ .
v) The most commonly used insulation in high voltage cables is _____ .
vi) Belted cables are generally used upto _____ kV.
vii) The working voltage level of belted cable is limited to 22 kV because of the _____ set up in the dielectric.
viii) For voltage beyond 6 kV,solid type cables are unrealiable because there is a danger of breakdown of insulation due to _____ .
ix) If the length f a cable increases,its insulation resistance _____ .
x) Under operating conditions,the maximum stress in a cable is at _____ .
xi) For voltages less than 66 kV,a 3-phase cable usually consists of _____ .
xii) If the length of a cable is double,its capacitance is _____ .
xiii) A certain cable has an insulation of relative permittivity 2.If the insulation is replaced by one of relative permittivity 4.then capacitance of cable is _____ .
xiv) The minimum dielectric stress in a cable is at _____ .
xv) If a cable of homogeneous insulation has maximum stress of 5 kV/mm,then the dielectric strength of insulation should be _____ .
xvi) In capacitance rading of cables,we use a _____ dielectric.
xvii) For the same safe potential,the size of a graded cable will be _____ .
xviii) For operating voltagesbeyond 66 kV _____ cables are used.
xix) Voids in the layers of impregnated paper insulation _____ the breakdown voltage of the cable.
xx) For voltages beyond 66 kV,3phase system usually employs _____ .
= Answer
i)more
ii) closer spacing
iii) moisture
iv) excessive sheath losses
v) impregnated paper
vi) 11
vii) tangential stresses
viii) presence of voids
ix) decreases
x) conductor surface
xi) 3-core cable
xii) doubled
xiii) doubled
xiv) lead sheath
xv) 5 kV/mm
xvi) composite
xvii) less
xviii) oil - filed
xix) decrease
xx) 3-single core cables

116) What is distribution system?
= Answer
The power system which distributes electric power for local use is known as distribution system.

117) What is feeder?
= Answer
A feeder is a conductor which connects the sub-station to the area here power is to be distributed.

118) Show by layout diagram for primary and secondary distribution system.
= Answer

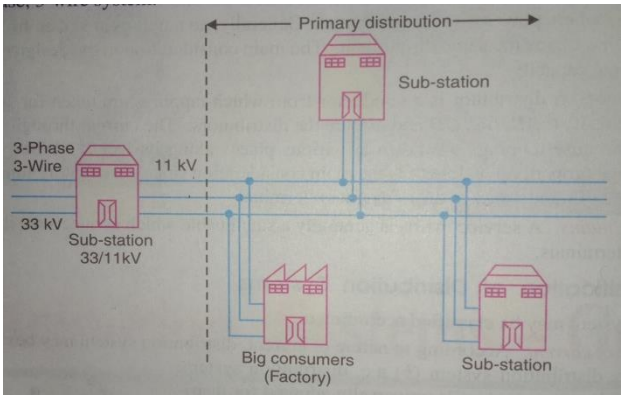



Fig. Primary Distribution

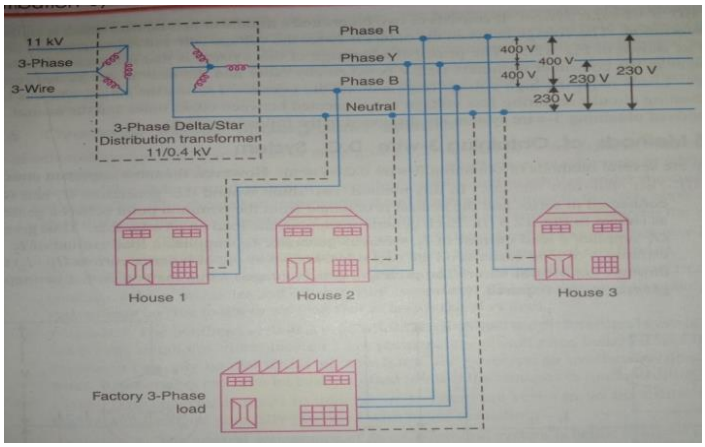



Fig. Secondary Distribution

119) What are the advantages of underground system over overhead system?
= Answer
i) Public safety : More safe.
ii) Faults : Very rare.
iii) Useful life : Much longer.
iv) Maintenance cost : Very low.
v) Interference with communication circuits : No interference.

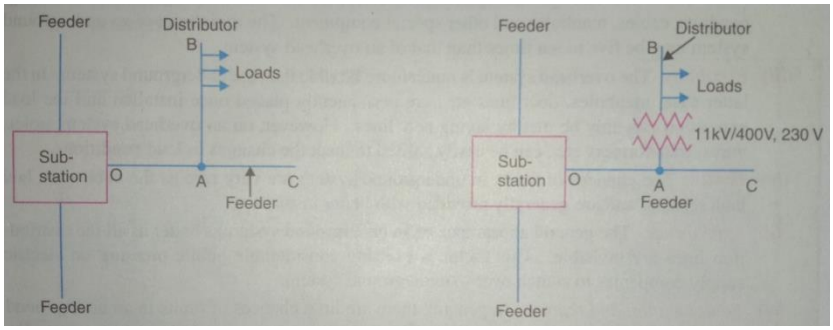
120) What are the disadvantages of underground system over overhead system?
= Answer
i) Initial cost : More expensive.
ii) Flexibility : Less flexible.
iii) Current carrying capacity : Low current carrying capacity.

121) State – connection schemes of distribution system.

= Answer

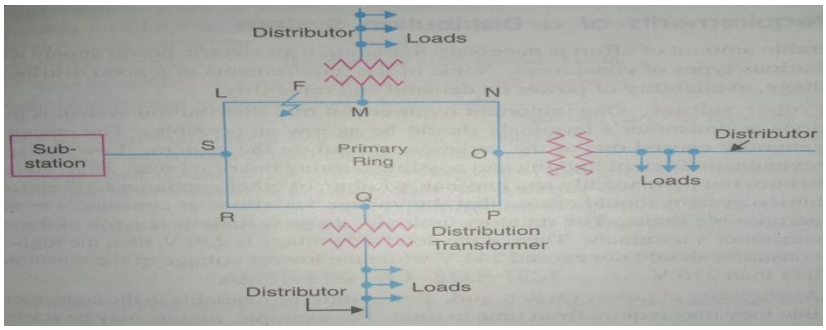
i) Radial system :

In this system,separate feeders radiate from a single sub-station and feed the distributors at one end only.It is employed when power is generated at low voltage and substation is loaded at the centre of the load.



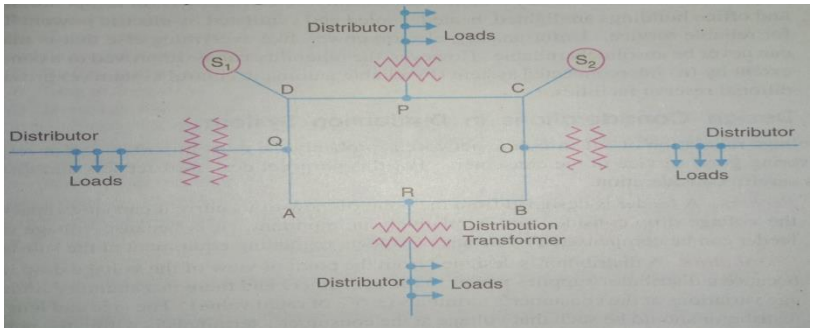

ii) Ringmain system :

In this system,the primaries of distribution transformers from a loop.The loop circuit starts From the distribution bus-bars.




iii) Interconnected system :

In this system,the primaries of distribution transformers form a loop.The loop circuit starts from the one or two substation bus-bars.




122) Fill up the following statements

i) The underground system has _____ initial cost than the overhead system.

ii) A ring main system f distribution is _____ reliable than the radial system.

iii) Thr distribution transformer links the primary and _____ distribution system.

iv) The most common system for secondary distribution is _____ 3-phase _____ wire system.

v) The statutory limit for voltage variations at the consumer terminal is _____ % of rated voltage.

vi) The service mains connect the _____ and the _____ .

vii) The overhead system is _____ flexible than underground system.

viiii) The main consideration in the design of a feeder is the _____ .

ix) A 3-wire d.c. distribution makes available _____ voltages.
x) Now–a -days _____ system is used for distribution.
xi) The interconnected system _____ the reserve capacity of the system.
xii) Rhe major part of investment on secondary distribution is made on _____ .
xiii) The chances f faults in underground system are _____ as compared to overhead system.
= Answer
i) more
ii)more
iii) secondary
iv) 400/230 V,4
v) $\pm$ 6
vi) distributor,consumer terminals
vii) more
viii) current carrying capacity
ix) two
x) a.c.
xi) increases
xii) distribution transformers
xiii) less

123) What is boosters?
= Answer
A booster is a d.c. generator whose function is to inject or add certain voltage into a circuit so as to compensate the IR drop in the feeders.

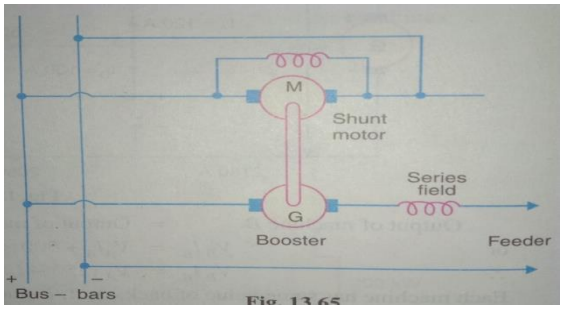
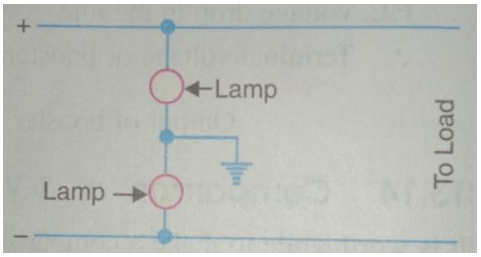


Fig. 13.65

A booster is series d.c. generator of large current carrying capacity and is connected in series with the feeder whose voltage drop is to be compensated.It is driven at constant speed by a shunt motor working from the bus-bars.As the booster is a series generator,therefore,voltage generated by it directly proportional to the field current which is here the feeder current.When the feeder current increases,the voltage drop in the feeder also increases.But increases feeder current results in greater field excitation of booster which injects higher voltage into the feeder to compensate the voltage drop.

125) What do you mean by ground detector?
= Answer
Ground detectors are the devices that are used to detect or indicate the ground fault for underground d.c. systems.
Lamps are generally used for the detection of ground fault.Each lamp should have a voltage rating equal to the line voltage.The two lamps in series,being subjected to half their rated voltage,will glow dimly.If a ground fault occurs on either wires,the lamp connected to the grounded wire will not glow while the other lamp will glow brightly.




126) Fill up the following statements
i) In singly fed distributor,if fault occurs on any section,the supply to all consumers has to be _____ .
ii) A ring main distributor fed at one end is equivalent to _____ fed at both ends with equal voltages.
iii) A distributor is designed from _____ considerations.
iv) The point of minimum potential of a uniformly loaded distributor fed at both ends with equal voltages will occur at _____ .
v) The d.c. interconnector is used _____ the voltage drop in the various sections of the distributor.
vi) In a 3-wire d.c. system,the load on positive side is 400 A and on negative side it is 300 A.Then current in neutral wire is _____ .
vii) In a balanced 3-wire d.c. system,the potential of neutral is _____ between that of outers.
viii) A booster is used to _____ voltage drop in feeders.
ix) Balancer set is used to maintain voltages on the two sides of the neutral _____ .
x) In a balanced 3-wire d.c. system,if voltage across the outer is 500 V,then voltage between any outer and neutral is _____ .
xi) The voltage drop in a doubly fed distributor is _____ than the equivalent singly fed distributor.
xii) In a 3-wire system,the area of cross section of neutral is generally _____ of either outer.
xiii) If in a 3-wire d.c. system,the current in the neutral wire is zero,then voltage between any outer and neutral is _____ .
xiv) A booster is connected in _____ with the feeder.
xv) For exact compensation of voltage drop in the feeder,the booster must work on _____ portion of its V-I characteristic.
xvi) The balancer machine connected to the heavily loaded side works as a _____ .
= Answer
i) shut off
ii) straight distributor
iii) voltage drop
iv) mid-point
v) to reduce
vi) 100 A
vii) midway
viii) compensate
ix) equal to each other
x) 250 V
xi) less
xii) half
xiii) the same
xiv) series
xv) linear
xvi) generator

127) Fill up the following statements

i) The most common system for secondary distribution is 400/ _____ V.3-phase _____ wire system.
ii) In a 3-phase,4-wire a.c. system,if the loads are balanced then current in the neutral ire is _____ .
iii) Distribution transformer links the _____ and _____ systems.
iv) The 3-phase,3-wire a.c. system of distribution is used for _____ loads.
v)For combined power and lighting oad _____ system is used.
vi) 3-phase,4-wire a.c. system ofdistribution is used for _____ load.
vii) In a balanced 3-phase,4-wire a.c. system,the phase sequence is RYB.If the voltage of R-phase $230<0^0$ volts,then for B phase it will be _____ .
viii) In a.c. system,additions and substractions of current are done _____ .
ix) The area of cross section of neutral is generally _____ that of any line conductor.
x) For purly domestic loads _____ a.c. system is employed for distribution.
= Answer
i) 230,4
ii) zero
iii) primary,secondary
iv) balanced
v) 3-phase,4-wire
vi) unbalanced
vii) $230<120^0$
viii) vectorially
ix) half
x) single phase.2-wire

128) Give a statements about importance of voltage control.
= Answer
i) If the supply voltage to an incandescent lamp decreases by 6% of rated value then illuminating power decrease by 20%.On the other hand,if the supply voltage is 6% above the rated value,the life of the lamp reduced by 50% due to deterioration of the filament.
ii) If the supply voltage is above 6% the normal,the induction motor operate with a saturated magnetic circuit,with consequent magnetizing current .heating and low power factor .On the other hand,if the supply is 6% below,it will reduce the starting torque of the motor.
iii) Too wide variations of voltage cause excessive heating of distribution transformers.

129) How many methods of voltage control?
= Answer
i) By excitation control.
ii) By using tap changing transformers.
iii) Auto-transformer tap hanging.
iv) Booster transformers.
v) Induction regulators.
vi) By synchronous condenser.

130) Fill up the following statements
i) The statutory limit of voltage variations is _____ of the declared voltage at consumer terminals.
ii) In the automatic voltage regulators used at the generating station,the _____ priniciple is used.
iii) The voltage variation in a Brown-Boveri regulator never exceed _____ .
iv) In a Tirril regulator ,a _____ resistance is cut in and out of the exciter field circuit of the alternator.
v) In practice,tap-changing is performed on load so that there is _____ to supply.

vi) Induction regulators are used for voltage control in _____ system.
vii) A synchronous condenser is generally installed at the _____ end of a transmission line.
viii) The principle cause of voltage variation is the change of _____ on the system.
ix) Ina Tirril regulator,capacitor is provided across the relay ontacts to reduce _____ at the time relay contacts are opened.
x) The voltage control equipment is used at _____ in the power system.
xi) The mechanical control torque in a Brown-Boveri regulator is _____ whatever may be the position of drum.
xii) The excitation control method is suitable only for _____ lines.
xiii) It is _____ to maintain the same voltage at both ends of a transmission line by synchronous condenser method.
= Answer
i) $\pm 6\%$
ii) overshooting the mark
iii) $\pm 1\%$
iv) regulating
v) no interruption
vi) primary distribution
vii) receiving
viii) load
ix) arcing
x) more than one point
xi) constant
xii) short
xiii) not economical

131) What do you mean by switchgear?
= Answer
The apparatus used for switching,controlling and protecting the electrical circuits and quipment is known as switchgear.

132) State essential features of switchgears.
= Answer
i) Complete reliability :
When fault occurs on any part of the power system,it must be reliable to isolate the faulty section from the healthy section.
ii) Quick operation :
When fault occur on any part of the power system,the switchgear must operate quickly.
iii) Provision for manual control :
When fault occur on any part of the power system,the necessary operation can be carried out through manual control after fault occurred.

133) Explain-switchgear equipments.
= Answer
i) Switches :
A switch is a device which is used to open or close an electrical circuits.
a) Air break switch :

In air break switch arcing horns are provided during opening the switch so arc is lengthened cooled and interrupted.It is used in an industrial load from a main ransmission line or feeder.it is designed to open circuit under load.

b) Isolator or disconnecting switch :

It is designed to open a circuit under no load.Such sweitches are generally used on both sides of circuit breakers in order that repairs and replacement of circuit breaker.They should be opened or closed before the circuit breaker opened or closed.

c) Oil switches :

The contacts of such switches are opened under oil,usually transformer oil.These switches are used for circuit of high voltage and large current carrying capacities.

ii) Fuses :

A fuse is a short piece of wire or third strip which melts when excessive current flows through it for sufficient time.

iii) Circuit breaker :

The function ofa circuit breaker is to isolate the faulty part of the power system in case of abnormal conditions.

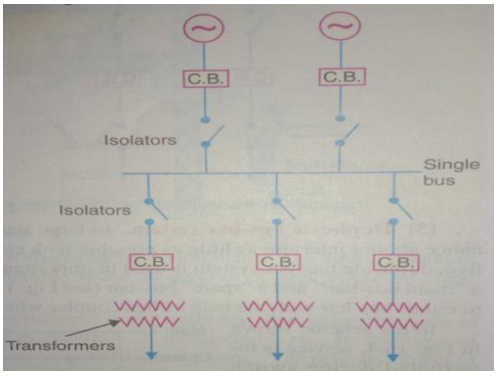
iv) Relays :

A relay is a protective device which detects the abnormal condition and sends a triping signal to the other devices.

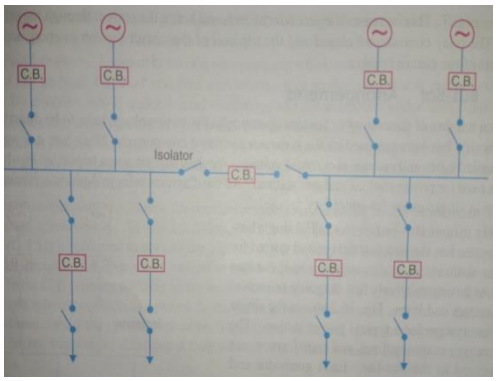
134) Draw a bus-bar arrangements.

= Answer

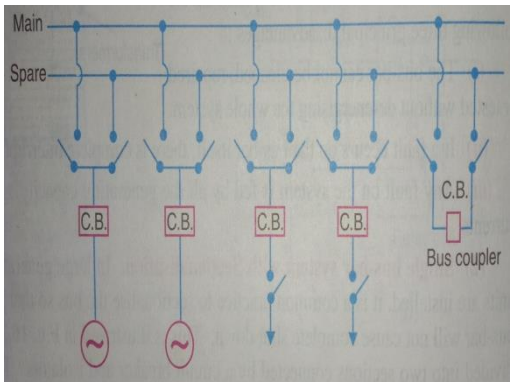
i) Single bus-bar system :




ii) Single bus-bar system with sectionalisation :




iii) Duplicate bus-bar system :




135) Fill in the blanks
i) A fuse is a _____ device.
ii) A circuit breaker is a _____ device.
iii) An isolator is esigned to open a circuit under _____ .
iv) When a switch is opened _____ is produced.
v) Under normal operating conditions,the contacts of the circuit breaker remain _____ .
vi) Under fault conditions,_____ supplies information to the circuit breaker to open.
vii) If a fault occur on the bus itself ina single bus-bar system,then there is complete _____ .
viii) The sectionalized bus-bar system gives _____ fault current than that of unsectionalised bus-bar.
ix) For greater flexibility _____ bus-bar system is used.
x) The outdoor type switchgear is generally used for voltages beyond _____ kV.
xi) A fuse performs _____ functions.
xii) The circuit breaker performs _____ function.
xiii) For voltages beyond 66 V,switchgear equipment is installed.
xiv) Bus-bar operate at _____ voltage.
xv) Isolator is an _____ switch.
= Answer
i)protective
ii) circuit interrupting
iii) no load
iv) arc
v) closed
vi) relay
vii) shut down
viii) lower
ix) duplicate
x) 66
xi) both detection and interruption
xii) circuit interruption
xiii) outdoor
xiv) constant
xv) air

136) Fill up the following statements
i) When a short circuit occurs,a _____current flows through the system.
ii) The most serious result of a major uncleared short circuit fault is the _____ .
iii) When all the three phases are short circuited,it gives rise to _____ currents.

iv) The rating of a circuit breaker is generally determined on the basis of _____ short circuit current.
v) The most common type of fault in overhead line is _____ .
vi) The _____ short-circuit fault gives very heavy duty on the circuit breaker.
vii) If the percentage reactance upto the fault point is 20%,then short circuit current will be _____ times.
viii) A 1000 KVA transformer with 5% reactance will have a reactance of _____ at 2000 KVA base.
ix) Short circuit KVA is obtained by multiplying the base KVA by _____ .
x) Reactors are used at various points in the power system to _____ .
xi) _____ fault gives rise to symmetrical fault currents.
xii) Percentage reactances _____ as they are referred through transformers.
xiii) If the percentage reactance of the system upto the fault point is 20% and the base KVA is 10,000,then short circuit KVA is _____ .
xiv) The use of reactors permits installation of circuit breaker of _____ ratings.
xv) A 20,000 KVA transformer with 10% reactance will have a reactance of _____ at 10,000 KVA base.
= Answer
i) heavy
ii) fire
iii) symmetrical fault
iv) symmetrical
v) phase-to-ground fault
vi) 3-phase
vii) 5
viii) 10%
ix) 100/%X
x) limit short-circuit current
xi) 3-phase short-circuit
xii) remain nchanged
xiii) 50,000
xiv) lower
xv) 5%

137) Fill up the following statements
i) The most common type of 3-Ø unsymmetrical fault is _____ .
ii) In a balanced 3-Ø system,negative and zero pahse sequence currents are _____ .
iii) In a 3-phase,4-wire unbalanced system,the magnetude of zero sequence current is _____ of the current in the neutral wire.
iv) The protective sequence impedance of a transmission line is _____ to the negative sequence impedance.
v) The zero sequence impedance of different elements of power system is generally _____ .
vi) A symmetrical fault on a power system is _____ severe than an unsymmetrical fault.
vii) The operator 'a' rotate the vector through _____ in the anticlock wise direction.
viii) On the occurance of an unymmetrical fault,the positive sequence component is always _____ than that of negative sequence component.
ix) The zero sequence impedance of an element in a power system is generally _____ the positive or negative sequence impedance.
x) a - $a^2$ = _____ .
= Answer
i) single line-to-ground

ii) zero
iii) one-third
iv) equal
v) different
vi) more
vii) $120^0$
viii) more
ix) different from
x) $j\sqrt{3}$

138) Fill up the following statements
i) A circuit breaker opens _____ when a fault current occurs on the system.
ii) A circuit breaker can _____ the circuit immediately after automatic operation.
iii) When the contacts of a circuit breaker are opened on the occurance of a fault,an _____ is struck.
iv) An a.c. circuit is more easily interrupted than a d.c. circuit because alternating current provides _____ .
v) If the length of the arc increases,its resistance is _____ .
vi) If dielectric strength of the medium between contacts builds up more rapidly than the re-striking voltage,then arc will be _____ .
vii) In an oil circuit breaker _____ is used as the arc quenching medium.
viii) The quantity of oil needed for arc control oil circuit breaker is _____ then that of plain break oil circuit breaker.
ix) Current chopping mainly occurs in _____ circuit breakers.
x) Capacitive current breaking results in _____ .
xi) Cross jet explosion plot breaker can interrupt _____ short circuit current efficiently.
xii) In forced blast oil circuit breaker,the extinguishing force is _____ the fault current to be interrupted.
xiii) In low oil circuit breakers _____ is used for insulation purposes.
xiv) Forced-blast circuit breaker have _____ speed of circuit interruption.
= Answer
i) automatically
ii) remake
iii) arc
iv) neutral current zero
v) increased
vi) extinguished
vii) some mineral oil
viii) less
ix) air blast
x) voltage surges
xi) heavy
xii) independent of
xiii) solid material
xiv) high

139) Describe characteristics of fuse element.
= Answer
i) Low melting point (lead,tin).
ii) High conductivity.
iii) No deterioration,

iv) Low cost.

140) Explain fuse law.
= Answer
When the fuse element attains steady temperature,
Heat produced per sec = Heat lost per second by convection,radiation and connection
$=> I^2R$ = Constant ×Effective surface area
$=> I^2(\rho\frac{l}{a})$ = Constant ×d×l [Where,d = diameter of fuse element
$=> I^2 \frac{\rho l}{(\frac{\pi}{4})d^2}$ = Constant×d×l l = length of fuse element]
$=> I^2$ = Constant×$d^3$
$\therefore I^2 \propto d^3$

141) Fill up the following statements
i) Fuses are generally used in circuit where _____ operations are not expected.
ii) The minimum time of operation of a fuse is _____ than that of a circuit breaker.
iii) A fuse element should have _____ melting point.
iv) The disadvantage of tin fuse element is that its vapour tends to _____ when its blows out.
v) The value of fusing factor is always _____ than unity.
vi) Semi enclosed rewireable fuse have _____ breaking capacity.
Vii) A fuse has _____ time current characteristic.
viii) The action of a fuse is _____ completely automatic.
ix) The fuse element is is generally made of _____ .
x) The fuse melts well _____ the first peak of fault current is reached.
xi) A fuse is _____ than other circuit interrupting device of equal breaking capacity.
xii) For the same material,heavy current fuse wire must have _____ diameter than for smaller currents.
xiii) A fuse performs _____ functions.
xiv) A fuse has _____ breaking capacity as compared to a circuit breaker.
= Answer
i) frequent
ii) smaller
iii) low
iv) maintain the arc
v) more
vi) low
vii) inverse
viii) inherently
ix) silver
x) before
xi) cheaper
xii) larger
xiii) both direction and interruption
xiv) low

142) What is sensitivity?
= Answer
It is the ability of the relay system to operate with low value of actuating quantity.

143) What is differential relay?
= Answer
A differential relay is one that operates when the phasor difference of two or more similar electrical quantities exceeds a predetermined value.

144) What type of fault occur in an alternator?
= Answer
i) Failure of primemover :
When input to the primemover fails,the alternator runs as a synchronous motor and draws some current from the supply system.
ii) Failure of field :
iii) Over current :
When breakdown of winding insulation or over load on the supply system occur.
iv) Over speed :
When sudden loss or the major part of load on the alternator loss occur.
v) Over voltage :
When sudden loss or the major art of load on the alternator loss occur.
vi) Unbalanced loading :
Unbalanced loading arises from faults to earth or fault between phases on the circuit external to the alternator.
vii) Stator winding faults :
When insulation failure of the stator windings occur.These faults may be fault between phase and ground,fault between phases and interturn fault involving turns of the same phase winding.

145) Fill up the following statements
i) The most commonly used system for the protection of generator is _____ .
ii) Automatic protection is generally _____ provided for field failure of an alternator.
iii) The chief cause of over speed in an alternator is the _____ .
iv) Earth relays have _____ current settings.
v) Buchholz relay is installed between _____ and conservator.
vi) Buchholz relay can also be used with oil immersed transformer equipped with _____ .
vii) For the production of a Δ/Y power transformers,the CTs on delta side must be connected in _____ and those on the star side in _____ .
viii) Overload protection is generally not provided for _____ .
ix) Buchholz relay is a _____ relay.
x) Automatic protection is generally not provided for _____ transformers.
xi) Buchholz relay can detects fault _____ oil level in the transformer.
xii) The most important stator winding fault of an alternator is _____ fault.
xiii) Balanced earth-fault protection is generally provided for _____ generators.
xiv) An earth-fault current is generally _____ than short circuit current.
xv) Merz-price circulating current principle is more suitable for _____ than _____ .
= Answer
i) circulating current system
ii) not
iii) sudden loss of load
iv) lower
v) main tank
vi) conservator
vii) star,delta

viii) alternators
ix) gas actuated
x) small distribution
xi) below
xii) earth
xiii) small size
xiv) less
xv) generators,transformers

146) Fill up the following statements
i) A relay performs the function of _____ .
ii) The relay operating coil is supplied through _____ .
iii) A 1 VA relay is _____ sensitive than a 3 VA relay.
iv) The minimum relay coil current at which the relay operates is called _____ .
v) Induction relays _____ be used with d.c. quantities.
vi) An over current relay having a current setting of 125% is connected to a supply circuit through a current transformer of ratio 400/5.The pick up value will be _____ .
vii) The pick value of a relay is 7.5 A and fault current n relay coil is 30 A.Its plug setting multiplier is _____ .
viii) Back up protection functions when _____ .
ix)Most of the relays on service on electric power system are _____ relays.
x) Induction relays are used with _____ quantities.
xi) Back up protection is generally employs for protection against _____ faults.
xii) Back-up protection is generally of _____ type.
= Answer
i) fault detection
ii) instrument transformers
iii) more
iv) pick-up value
v) cannot
vi) 6.25 A (5×125%)
vii) 4 (30/7.5)
viii) primary protection fails
ix) electro-mechanical
x) a.c.
xi) short-circuit
xii) non-unit

147) Fill up the following statements
i) Differential protection scheme for longer lines is _____ costly.
ii) The bus-bar zone for the purpose of protection includes _____ and _____ .
iii) The two most commonly used schemes for bus bar protection are _____ and _____ .
iv) The probability of faults occurring on the lines is much more due to their _____ and _____ .
v) In time graded over current protection _____ discrimination is in corporate.
vi) The parallel feeders _____ be protected by non-directional over current relays alone.
vii) The translay scheme is essentially a _____ balance system.
viii) A summation transformer is a device that reproduces the polyphase line currents as a _____ phase quantity.
ix) The ideal scheme of protection for lines is _____ protection.
x) Accurate matching of current transformers is _____ in Merz-price voltage balance system.

= Answer
i) very
ii) bus-bars,isolating switches,circuit breakers
iii) differential protection,fault bus protection
iv) greater length,exposure to atmosphere conditions
v) time
vi) cannot
vii) voltage
viii) single
ix) differential
x) essential

148) Explain causes of over voltages.
= Answer
i) Internal causes :
a) Switching surges
b) Insulation failure
c) Arcing ground
d) Resonance
ii) External causes :
a) Lightning
i)
a) The over voltage produced on the power system due to awitching operations are known as switching surges.
b) The most common case of insulation failure in a power system is the grounding of conductor which may cause over voltage in the system.
c) The phenomenon of intermittent arc taking place in line-to-ground fault of a 3-Ø system with consequent production of transients is known as arcing ground.
d) Resonance in an electrical system occurs when inductive reactance of the circuit becomes equal to capacitive reactance.
ii)
a) An electric discharge between cloud and earth,between clouds or between the charge centres of the same cloud is known as lightning.

149) Explain protection against lightning.
= Answer
i) Earthing screen :
It consists of a network of copper conductors mounted all over the electrical equipment in the sub-station or power station on the occurance of direct stroke on the ststion,screen provides a low resistance path by which lightning surges are conducted to ground.
ii) Overhead ground wires :
Protection of transmission lines against direct lightning strokes is by the overhead ground wires.The ground wires are grounded at each tower or pole through as low resistance as possible.
iii) Lightning arresters or surge diverters :
A lightning arrester or a surge diverter is a protective device which conducts the high voltage surges on the power sytem to the ground.

150) How many types of lightning arrester?
= Answer

i) Rod-gap arrester :

It is a very simple type of diverter and consists of two 1.5 cm rods which are bent at right angles with a gap in between.One rod is connected to the line circuit and the other rod is connected to earth.The distance between gap and insulator must not be less than one-third of the gap length so that the arc may not reach the insulator and damage insulator.The gap legth is so adjusted that break down occur at 80% of spark over voltage.

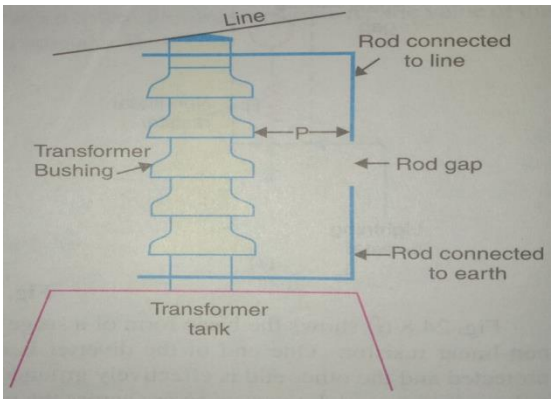



Fig. Rod-gap arrester

ii) Horn gap arrester :

It consists of two horn shaped metal rods A and B seperated by a small air-gap.The horns are so designed that distance between them gradually increases towards the top.The horns are mounted on porcelain insulators.One end of horn is connected to the line through a resistance R and choke coil L while the other end is grounded.The resistance R helps in limiting the current.The choke L is so designed that it offers small reactance at normal power frequency but a very high reactance at transient frequency.Thus the choke does not allow the transients to enter the apparatus to be protected.

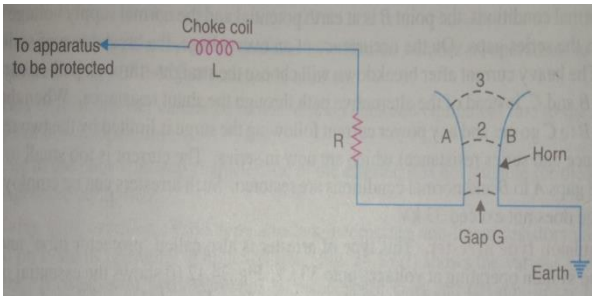



Fig. Horn gap arrester

iii) Multigap arrester :

It consists of a series of metallic cylinders insulated from on another and separated by small intervals of air gaps.The first cylinder ‘A’ in the series is connected to the line and the other to the ground through a series resistance.The series resistance limits the power arc also reduced travelling waves.

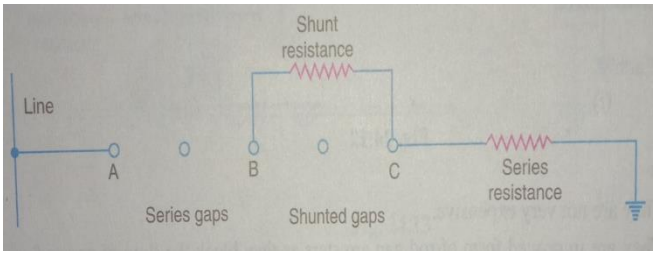



Fig. Multigap arrester

iv) Expulsion type arrester :

It consists of a rod gap in series with a second gap enclosed within the fibre tube.The gap in the fibre tube is formed by two electrodes.The upper electrode is connected to rod gap and the lower electrode to the earth.It is used at voltages upto 33 kV.

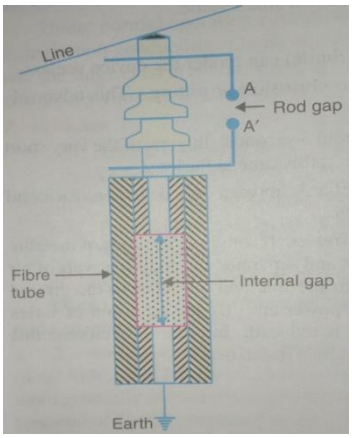



Fig. Expulsion type arrester

v) Valve type arrester :

151) What is surge absorber?

= Answer

A surge absorber is a protective device which reduces the steepness of wave front of a surge by absorbing surge energy.

152) Fill up the following statements

i) The most severe surges on the lines are produced by _____ .

ii) Lightning produces a _____ fronted wave.

iii) Transients on the power system due to current chopping are taken care of by _____ .

iv) Arcing ground can be presented by _____ .

v) The lighting currents range from 10 KA to about _____ KA.

vi) For successful working of ground wire,the footing resistance of tower should be _____ .

vii) A surge diviter should be located _____ to the apparatus to be protected.

viii) A 1/50 μs surge is _____ harmful than 3/50 μs surge.Assume the same peak value.

ix) The _____ lightning strokes are very rare on the power system.

x) Most of the lightning strokes are due to _____ charge clouds.

xi) The stroke will always occur on _____ .

xii) In sub-stations,the most commonly used type of arrester is _____ arrester.

xiii) _____ cannot protect the equipment from the travelling waves reaching the equipment.

xiv) Surge absorbers are used to _____ the steepness of wave front of the surge.

= Answer
i) lightning
ii) steep
iii) resistance switching
iv) earthing the neutral
v) 90
vi) low
vii) close
viii) more
ix) direct
x) negatively
xi) tallest object
xii) thyrite
xiii) ground wires
xiv) reduce

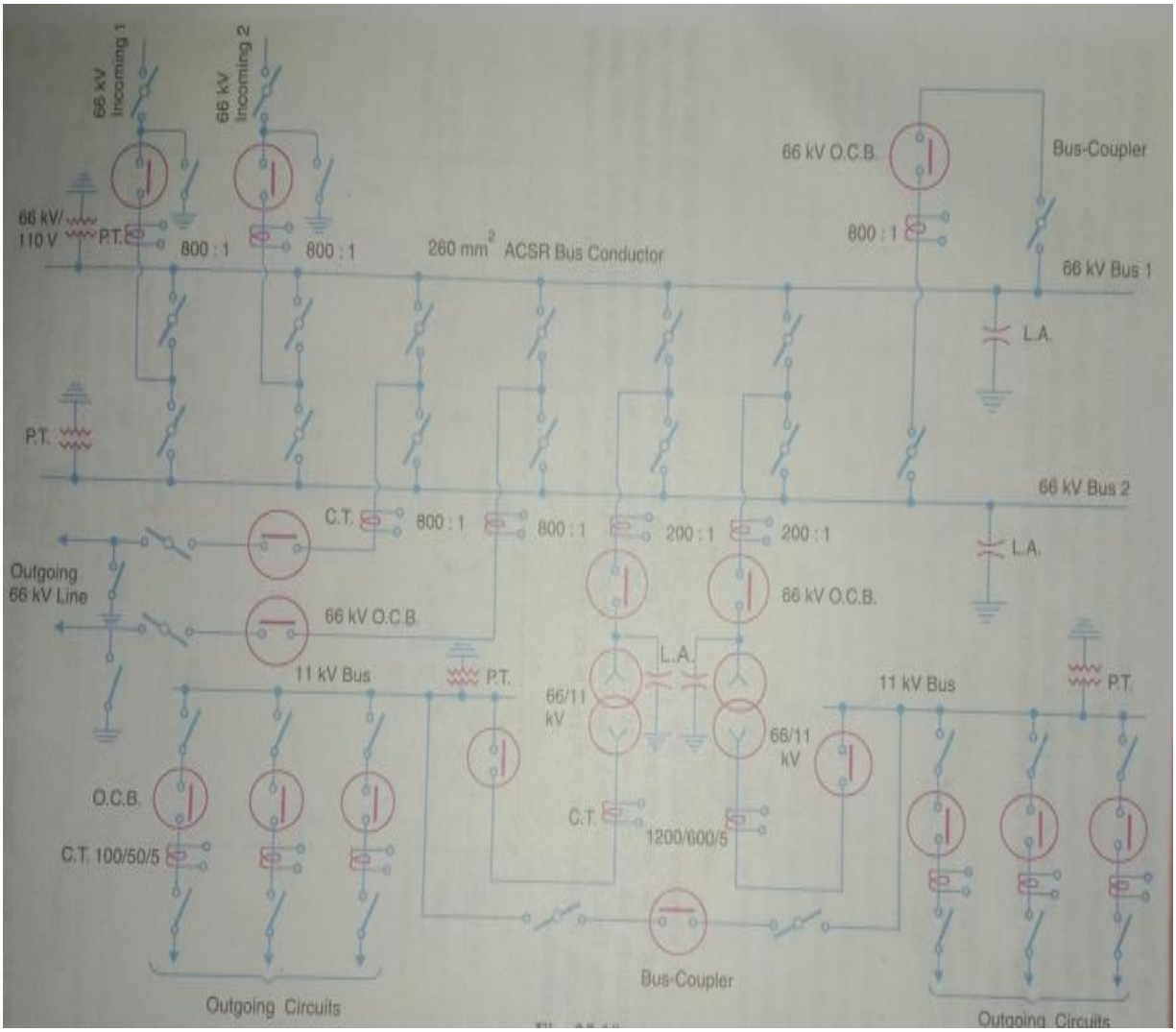
153) What do you mean by sub-station?
= Answer
The assembly of apparatus used to change some characteristic i.e. voltage,a.c. to d.c.,frequency,p.f. etc of electric supply is called a sub-station.

154) State classification of sub-station.
= Answer
i) According to service requirement :
a) Transformer sub-station : change the voltage level.
b) Switching sub-station : simply switching operations.
c) Power factor correction sub-station : improves the power factor.
d) Frequency change sub-station : change the supply frequency.
e) Converting sub-station : change a.c. power into d.c. power.
f) Industrial sub-station : supply power to individual industrial concerns.
ii) According to constructional features :
a) Indoor sub-station : For voltages upto 11 kV.
b) Outdoor sub-station : For voltages beyond 66 kV.
c) Underground sub-station : In thickly populated area.
d) Pole mounted sub-station : For voltages upto 11 kV.

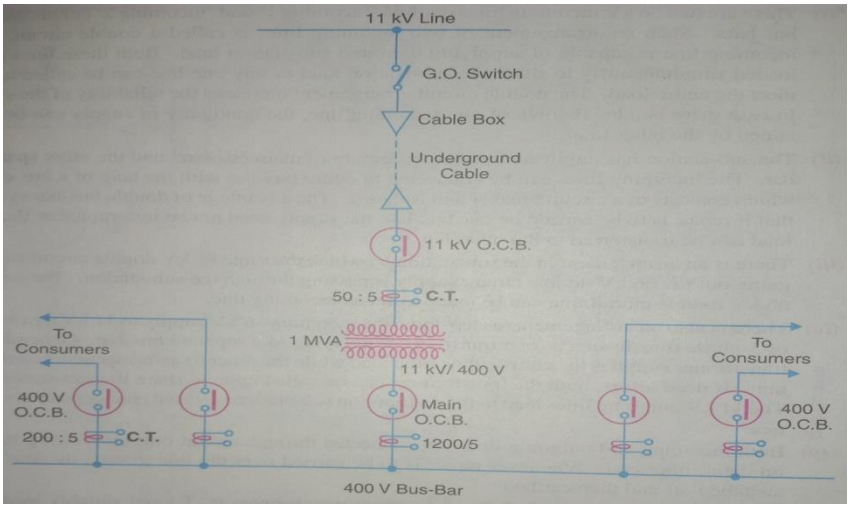
155) Explain equipment in a transformer sub-station.
= Answer
1) Bus-bar : Bus-bar are copper or aluminium bars generally or rectangle cross section and oprate at constant voltage.
i)Single bus-bar arrangement.
ii) Single bus-bar system with sectionalisation.
iii) Double bus-bar arrangement.
2) Insulators : They support the conductors or bus-bar and confine the current to the conductors.
3) Isolating switches : In sub-stations,it is often desired to disconnect a part of the system for general maintenance and repairs.It is done by first opening the circuit breaker than the isolator switches.
4) Circuit breaker : A circuit breaker is an equipment which can open or close a circuit under normal as well as fault conditions.

5) Power transformer : A power transformer is used in a sub-station to step-up or step-down the voltage.
6) Instrument transformer : Generally measuring instruments and protective devices are designed for low voltages (110V) and currents (5A).Therefore,they will not work properly if directly connected to the power lines which high voltages and currents.It is overcome by installing instrument transformers on the power lines.
a) Current transformer : A C.T. is essentially a step-up transformer which steps down the current to a known ratio.Suppose a C.T. rated at 100/5 A is connected in the line to measure current.If current in the line is 50 A,then secondary of C.T. will have a current of $(50\times\frac{5}{100})$ =2.5 A.
b) Potential transformer : A P.T. is essentially a step-down transformer which step down the voltage to a known ratio.
7) Metering and indicating instruments : Ammeter.,voltmeter,energy meters.
8) Miscellaneous equipment : Fuses,carrier-current equipment and sub-station auxiliary supplies.

156) Layout of 66/11 kV sub-station.
= Answer



157) Layout of 11 kV/400 V sub-station.
= Answer




158) Fill up the following statements.
i) A sub-station _____ some characteristic of electric supply.
ii) Most of the sub-stations in the power system change _____ of electric supply.
iii) An ideal isolation for the sub-station would be at the _____ of load.
iv) Pole mounted sub-stations are used for _____ distribution.
v) The voltage rating of the transformer in a pole mounted sub-station is _____ .
vi) Single bus-bar arrangement in sub-station is used for voltages less than _____ .
vii) For voltages greater than 33 kV _____ bus-bar arrangement is employed.
viii) The kVA rating of transformer in a pole mounted sub-station does not exceed _____ .
ix) An indoor sub-station is _____ expensive than outdoor sub-station.
x) Fault location is _____ in an outdoor sub-station than in indoor sub-station.
xi) Outdoor sub-station requires _____ space.
xii) The possibility of fault escalation is _____ in outdoor sub-station than that of indoor sub-station.
xiii) Majority of distribution sub-station are of _____ type.
xiv) Power factor correction sub-stations are generally located at the _____ end of a transmission line.
xv) Underground sub-stations are generally located in _____ .
= Answer
i) changes
ii) voltage level
iii) centre of gravity
iv) secondary
v) 11 kV/40 V
vi) 33 kV
vii) duplicate
viii) 200
ix) more
x) easier
xi) more
xii) less
xiii) pole-mounted
xiv) receiving
xv) thickly populated areas

159) State Ohm's law.
= Answer
The ratio of potential difference between any two points on a conductor to the current flowing between them,is constant,provided the temperature of the conductor does not change.

$$\frac{V}{I} = \text{Constant} = \text{R}$$

160) State Kirchhoff's current law.
= Answer
In any electrical networks,the algebraic sum of the current meeting at a point or junction is zero.

161) State Kirchhoff's voltage law.
= Answer
The algebraic sum of the products of current and resistances in each of the conductor in any closed path or mesh in a network plus the algebraic sum of the emf's in that path is zero.

$$\Sigma \text{ IR} + \Sigma \text{ e.m.f.} = 0$$

162) State maximum power transfer theorem.
= Answer
A resistive load will abstract the maximum power from a network hen the load resistance is equal to the resistance of the network.

163) State Superposition theorem.
= Answer
In a network of linear resistance containing more than generator or emf,the current which flows at any point is the sum of all the currents which would flow at that point if each generator where considered separately and all the other generator or emf replaced for the time being by resistances equal to their internal resistances.

***My another topic of Electrical Engineering is Control System Theory will coming soon***