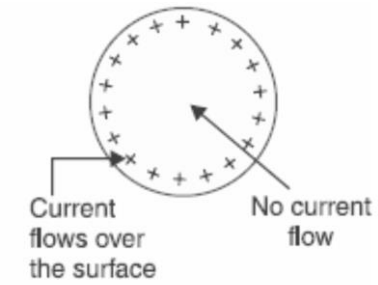
U20EE403 - TRANSMISSION AND DISTRIBUTION

Two marks Q&A

UNIT I TRANSMISSION LINE PARAMETERS

1. **What is skin effect?(May/June 2014) (Nov/Dec 2012) (Nov/Dec 10)(Nov/Dec2016)(Or)State skin effect in transmission lines. Mention its effect on the resistance of the line.(April/May 2017) (NOV/DEC 2018)**

When a conductor carries a steady or D.C current, this current is uniformly distributed over the whole cross section of the conductor. However the current distribution is non-uniform if the conductor carries alternating current. The current density is higher at the surface than at the center. Thus the current is concentrated near the surface of the conductor. This effect becomes predominant with increase in frequency. This behavior of alternating current to concentrate near the surface of the conductor is known as skin effect.



The skin effect causes the effective resistance of the conductor to increase at higher frequencies where the skin depth is smaller, thus reducing the effective cross-section of the conductor.

2. **Define the term critical disruptive voltage. (Nov/Dec 2013)**

It is the minimum phase to neutral voltage at which the electric field intensity at the surface of the conductor exceeds the critical value and generates corona.

3. **What is proximity effect? (May/June 2014) (May/June 2013)(April/May 2011)(APR/MAY 2015) (APRIL/MAY 2018) (NOV/DEC 2018)**

The alternating magnetic flux in a conductor caused by the current flowing in a neighboring conductor gives rise to a circulating current which cause an apparent increase in the resistance of the conductor. This phenomenon is called as proximity effect.

4. **What is meant by inductive interference? (NOV/DEC 2017)**

Usually, communication lines are run along the power lines; in some cases, these lines are run on the same support and the same route. Under such conditions the power lines are likely to interfere with the communication lines. The interference is mainly due to electromagnetic and electrostatic fields.

5. **What are the factors that affect the skin effect? (NOV/DEC 2016)**

Factors that affect the skin effect:

i. Nature of the material
ii. Diameter of wire – increases with the increase diameter of wire
iii. Frequency – increases with increase in frequency
iv. Shape of wire – less for stranded conductor than that for the solid conductor

6. **Why the effective resistance is more than the static resistance of a transmission line? (NOV/DEC 2018)**

Due to skin effect, the effective area of cross-section of a conductor through which current flows is reduces. Consequently, the resistance of the conductor slightly increases when carrying an

alternating current. Hence the effective resistance or AC resistance of a transmission line is greater than static or DC resistance due to the skin effect.

7. Why does a transmission lines have resistance, inductance, and capacitance? (NOV/DEC 2018)

A transmission line has resistance, inductance, and capacitance uniformly distributed along the whole length of the line. The each parameter is defined as follows.

Resistance: This is due to the opposition offered by the conductor to the flow of current.

Inductance: When an alternating current flows through a conductor, a changing flux is set up that links the conductor. Due to these flux linkage, the conductor possesses an inductance.

Capacitance: The conductors of an overhead transmission line are separated by air, which acts as an insulation. Therefore, a capacitance exists between any two overhead line conductors.

8. Why skin effect is absent in dc system? (April/May 2015)

When a conductor carries a steady or D.C current, this current is uniformly distributed over the whole cross section of the conductor. That is why skin effect is absent in D.C system

9. Mention the transmission voltages that are followed in Tamil Nadu. (April/May 2015) (April/May 2017)

- 400/230 kV substations.
- 230/110 kV substations.
- 110 kV substations.
- 33 kV substations.

less than this kV transmissions as 22 kV and 11 kV are used for distribution.

10. Why transmission lines are 3 phase 3-wire circuits while distribution lines are 3phase 4 wire circuits? (Nov/Dec 13)

A Balanced 3 phase circuit does not require the neutral conductor, as theinstantaneous sum of the 3 line currents is zero. Therefore the transmission linesand feeders are 3 phase 3 wire circuits. The distributors are 3 phase 4 wire circuitsbecause a neutral wire is necessary to supply the 1 phase loads of domestic andcommercial consumers.

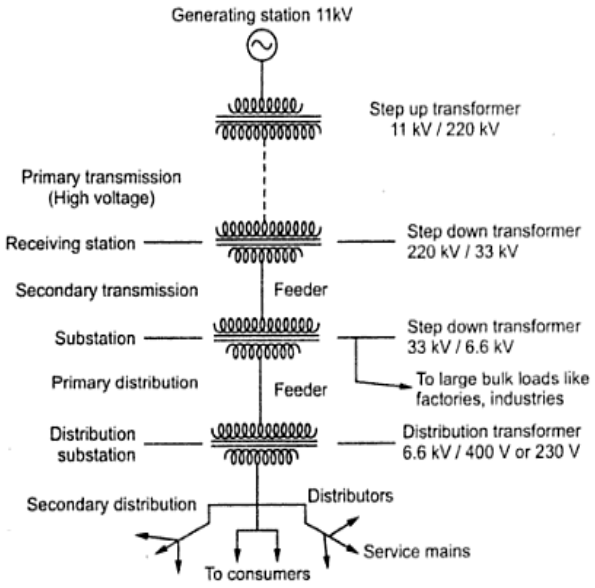
11. List out the practical transmission and distribution voltage levels commonly used. (April/May 2014)

GENERATION		6.6 KV, 10.5 KV, 11 KV, 13.8 KV, 15.75 KV
TRANSMISSION	**PRIMARY**	220KV, 110 KV, 132 KV, 765 KV
	SECONDARY	33 KV or 66 KV
DISTRIBUTION	**PRIMARY**	11 KV or 6.6 KV
	SECONDARY	415 V for 3ϕ
		230 V for 1ϕ

12. Name any four types of line supports. (April/May 2013)

Wooden poles, RCC poles, Steel tubular poles, Steel towers

13. Draw a single line diagram of a modern electric power system. (April/May 2014)



14. Why high voltage is preferred for power transmission?(APR/MAY 2015) (Nov/Dec2015)

The power that is generated will be of high current. In order to reduce the current voltage is increased so that the copper usage will be reduced.

Another reason for high voltage transmission is that losses can be reduced.

15. What are the components of Power System? (May/June 2014)

- Generators,
- Transformer
- Transmission Lines,
- Control Equipments,

16. What are the factors on which conductor spacing and ground clearance depend? (Nov/Dec 14)

- Nominal system Voltage,
- Maximum Voltage,
- Size of the conductor,
- Sag and Tension,
- Diameter and shape of conductor.

17. State the advantages of interconnected systems. (April/May 2017)

Any area fed from one generating station during overload hours can be fed from another power station and thus reserved capacity required is reduced, reliability of supply is increased and efficiency is increased.

18. Mention the disadvantages of a 3 wire system (April/May 2017)

In 3 wire system a third wire is required .The safety is partially reduced .A balancer is required and therefore cost is increased.

19. Why the concept of self GMD is not applicable for capacitance calculation? (NOV/DEC 2017)

Self-GMD of a conductor depends upon the size and shape of the conductor and is independent of the spacing between the conductors so it is not applicable for capacitance calculation.

20. What is meant by transposition of line conductors? (April/May 2011)(APR/MAY 2016)(NOV/DEC 2017)

It is the exchange of position of the power conductors at regular intervals along the line so that each conductor occupies the original position of every other conductor over an equal distance.

21. Mention the advantages of using bundled conductors.(Nov/Dec2016)

i. Reduced reactance
ii. Reduced voltage gradient
iii. Reduced corona loss
iv. Reduced radio Interference
v. Reduced surge impedance.

22. Differentiate the stranded conductor and bundled conductor. (April/May 2013)

S.NO	STRANDED CONDUCTOR	BUNDLED CONDUCTOR
1	It is the conductors made of thin wires of small cross section and bunched together	It is a conductor made up of two or more conductors called sub conductors, per phase in close proximity compared with space between phases
2	Reactance is more	Reactance is less
3	More corona loss	Less corona loss
4	More interference with communication lines	Less interference with communication lines

23. List out the advantages of double circuit lines. (April/May 2011)

Advantages of double circuit lines:

i. Half of the load is shared by the other line
ii. The increase in load current can be easily handled
iii. In case of power failure in one circuit, the power will be supplied by the other lines

24. Define - Self and mutual – G.M.D.(NOV/DEC 2015)

Self -GMD (GMR): The self-GMD means self-geometrical mean distance. It reduces the complexity of inductance calculation.

GMR = 0.7788 r

Mutual GMD: The mutual GMD is the geometrical mean of the distances from one conductor to the other.

25. State different types of overhead conductors. (April/May 2017

- AAC : All Aluminium Conductor
- AAAC : All Aluminium Alloy Conductor
- ACSR : Aluminium Conductor, Steel Reinforced
- ACAR : Aluminium Conductor, Alloy Reinforced

26. State why transposition of line conductors are needed? Or What is the need of transposition? (Nov/Dec 2011)

In order to make voltage drops equal in all conductors, generally we interchange the positions of the conductors at regular intervals along the line so that each conductor occupies the original position of every other conductor over an equal distance. Such an exchange of conductor position is called transposition.

27. List the factors that governing the capacitance of a transmission line. (April/May 2010)

Factors that governing the capacitance of transmission line:

i. The potential of the conductor
ii. Spacing between the lines
iii. Distance between the line and earth
iv. The length of lines
v. Number of conductors per phase

28. Write the advantages of ACSR conductor when used for overhead line. (April/May 2011)

i. Line span can be increased
ii. They have low corona loss
iii. Skin effect is less
iv. They are inexpensive

29. What is the effect of bundled conductors on transmission line inductance? (April/May 2014)

With the use of bundled conductors, there is increase in GMR. The formula for inductance contains the term GMR in the denominator. Hence the inductance of a bundled conductor line is less than the inductance of the line with one conductor/ph.

30. Give the minimum ground clearance required for 33 KV, 66 KV, 110 KV, 220 KV lines.

$$\text{x KV} = 5.18 + \left\lfloor \frac{\text{x} - 33}{33} \times 0.3048 \right\rfloor$$

For 33 KV – 5.18 m
66 KV – 5.4848 m
110 KV – 5.89 m
220 KV – 6.9 m

31. Give the advantages of bundled conductors. (Nov/Dec 14)(Nov/Dec 10)

- Reduced reactance, Reduced voltage gradient,
- Reduced corona loss, Reduced Interference

32. Write the expression for capacitance of single phase line.(Nov/Dec 2012)

$C=2\pi\varepsilon_0$ /log (d/r) F/m

33. A three phase transmission line has its conductor at the centers of an equilateral triangle with side 3m.The diameter of each conductor is 1.63cm.Find the inductance per km per phase of the line. (APR/MAY 2015)

34. What is the need of transposition? (Nov/Dec 2011) (NOV/DEC 2017)

- To make voltage drops equal for all the phases
- Reduce the disturbance to nearby communication circuits
- Effect of unbalanced current is neutralized.

35. Define: Visual Critical Voltage.(May/June 2013) (Nov/Dec 2011)

It is the critical voltage at which the corona is viewed as faint violet luminescence glow to our naked eyes.

36. Define Ferranti effect. (Nov/Dec 13) (Nov/Dec 10) (APR/MAY 2015) (April/May 2017) (May/June 13) (Nov/Dec 2011) (APR/MAY 2016) (APRIL/MAY 2018)

For along transmission line under no load condition, the voltage at the receiving end is more than that at sending end because of the effect of the line capacitance. This effect is called as Ferranti effect.

Unit 2- MODELLING AND PERFORMANCE OF TRANSMISSION LINES

1.Define voltage regulation of transmission line. (Nov/Dec 13)
(Nov/Dec 12)

Voltage regulation is defined as the change in voltage at the receiving (or load) end when the full-load is thrown off, the sending-end (or supply) voltage and supply frequency remaining unchanged

Where V_s is the voltage at the sending end
V_r is the receiving end voltage.

2.What is shunt compensation? (Nov/Dec 10)

Shunt compensation is the uses of shunt capacitors and shunt reactors in the line to avoid voltage instability.

3.Distinguish between attenuation and phase constant. (Nov/Dec 2011)

S.NO	ATTENUATION CONSTANT.	PHASE CONSTANT.
1	The real part of propagation constant	The imaginary part of propagation constant
2	It is denoted by α	It is denoted by β
3	It is the change in the magnitude per unit length of the line	It is the change in the phase per unit length of the line
4	It is expressed in nepers per unit length	It is expressed in radians per unit length

4.What are the factors which govern the performance of transmission line?(April/May 2011)

i. Series resistance
ii. Series inductance
iii. Shunt capacitance
iv. Shunt conductance.

5.What is surge impedance loading? (April/May 2011) (APRIL/MAY 2018)

Surge impedance loading of a line is the power delivered by a line to a purely resistive load equal to its surge impedance.

$$\text{surge impedance loading}, SIL = \frac{Vr^2}{Z_c}$$

6.Classify transmission line based on its length.How are transmission line classified? .(Nov/Dec 2017)

i. Short transmission
ii. Medium transmission
iii. Long transmission

7.Define transmission efficiency.(Nov/Dec 2015)

Efficiency defined as the ratio of power delivered at the receiving end to the power sent from the sending end.

$$transmission\ efficiency = \frac{receiving\ end\ power}{sending\ end\ power} \times 100$$

8.Give the formula for surge impedance(Nov/Dec 2015)

$$Z_c = \sqrt{\frac{Z}{Y}}\ or Z_c = \sqrt{Z_{oc}} Z_{sc}$$

Where Z_{oc} and Z_{sc} are impedances measured at sending end with the receiving open circuited and short circuited.

9.What is the use of power circle diagram? (April/May 2015)

Circle diagram helps us to study various aspects of power transmission at sending end and receiving end.

PR, PS, QR, Qs, ,δ,α,βcan be calculated.

10.List out the methods of representation of medium line. (April/May 2015)

i. Nominal T method
ii. Nominal π method
iii. End condenser method

11.Mention the factors affecting corona. (Nov/Dec 2011)

i. Atmosphere
ii. conductor size
iii. spacing between conductors and line voltage.

12.Define critical disruptive voltage.(Nov/Dec 2011)

It is defined as the minimum phase voltage at which corona occurs.

13.What are the main advantages of corona? (Nov/Dec 2014)

Due to corona formation, the air surrounding the conductor becomes conducting and hence virtual diameter of the conductor is increased. The increased diameter reduces the electrostatic stresses between the conductors.

Corona reduces the effects of transients produced by surges.

14.Define corona.(APR/MAY 2016) (NOV/DEC 2018)

When an alternating potential difference is applied across two conductors whose spacing is large as compared to their diameters, there is no apparent change in the condition of atmospheric air surrounding the wires if the applied voltage is low. However, when the applied voltage exceeds a certain value, called critical disruptive voltage, the conductors are surrounded by a faint violet glow called corona.

The phenomenon of corona is accompanied by a hissing sound, production of ozone, power loss and radio interference. This phenomenon happens due to ionization of air and it is called corona.

15.What is the cause of Ferranti effect? (NOV/DEC 2018)

Under light load condition or no load condition of a long transmission line, Ferranti effect exists.

16.What are the different methods of reducing corona loss? (APRIL/MAY 2018)

i. By increasing the conductor size
ii. By increasing the conductor spacing.
iii. By using hollow and bundled conductors.

17.What are the main disadvantages of corona? (NOV/DEC 2018)

i. Corona is accompanied by a loss of energy. This affects the transmission efficiency of the line.

ii. Ozone is produced by corona and may cause corrosion of the conductor due to chemical action.

iii. The current drawn by the line due to corona is non-sinusoidal and hence non-sinusoidal voltage drop occurs in the line. This may cause inductive interference with neighbouring communication lines.

18.Why series compensation is used in long series? (NOV/DEC 2014)

i. To increase transmission capacity

ii. To improve system stability.

iii. To obtain correct load division between parallel circuits.

19.Give any two reasons to minimize the reactive power transfer in lines. (NOV/DEC 2012)

i. Leads to voltage stability.

ii. Results in greater real and reactive losses.

20.Define Voltage Regulation of a Transmission Line. (Nov/Dec 13) (Nov/Dec 12) (May/June 2014)

Voltage regulation is defined as the change in voltage at the receiving end (load) and when the full load is thrown off, the sending end (supply) voltage and supply frequency remains unchanged.

% Voltage Regulation = ((Vs-Vr)/Vr)*100

Where Vs=Sending End Voltage,

Vr=Receiving End Voltage.

21.What is the difference between nominal T and nominal π methods? (May/June 2014)

In nominal T method, the total capacitance of each conductor is concentrated ***at the centre of the line*** and half the line impedance is lumped on its either side. Which is used for obtaining the performance calculation of medium lines.

In nominal **π**method, one half of the total capacitance of each conductor is lumped ***at both the ends.*** Which is used for obtaining the performance calculations of a medium line.

22.What is meant by 'natural loading' of a transmission lines? (Nov/Dec 14)

The natural or surge impedance loading or SIL of a transmission line is the MW loading of a transmission line at which a natural reactive power balance occurs. It is the maximum power transmitted when a lossless line operating at its nominal voltage, is terminated with a resistance equal to surge impedance of the line.

23.Why the control of reactive power is essential for maintaining a desired voltage profile? (Nov/Dec 14)

- To produce substantially flat voltage profile,
- To improve the system stability,
- To increase the power transfer capacity.

24.What is the range of surge impedance for over head lines? (May/June 13)

- For Over head lines, surge impedance is 400 ohm.

25.What is the range of surge impedance for under ground lines? (May/June 13)

- For Underground lines, surge impedance is 40-50 ohm.

26.What is the importance of voltage control? (APR/MAY 2015)

The task of voltage control is closely associated with fluctuating load conditions and corresponding requirements of reactive power compensation. Therefore several voltage control methods are employed in power system to keep the voltage levels within the desirable limits.

27.Mention the significance of surge impedance loading(APR/MAY 2016)(APR/MAY 2017)

Surge Impedance Loading is a very essential parameter when it comes to the study of power systems as it is used in the prediction of maximum loading capacity of transmission lines.

28.States the condition for maximum power delivered and draw the power angle diagram. (Nov/Dec 16)

. The power transfer across the line is therefore:

$$\boldsymbol{S = V_r}\left[\frac{\boldsymbol{V_s - V_r}}{jX}\right]^* = \frac{V_r e^{-j\phi_2}(V_s e^{j\phi_1} - V_r e^{j\phi_2})}{-jX}$$

$$= j\frac{V_s V_r}{X}e^{-j(\phi_2-\phi_1)} - j\frac{V_r^2}{X} = \frac{V_s V_r}{X}\sin\delta + j\frac{V_r}{X}(V_s\cos\delta - V_r)$$

Where

$$\delta = \phi_2 - \phi_1$$

is called the power angle, which is the phase difference between the voltages on bus 1 and bus 2.

29.Mention the various methods of voltage control in transmission lines.(Nov/Dec 16)

- Excitation control and voltage regulators at the generating stations:
- Use of tap changing transformers at sending end and receiving end of the transmission lines
- Switching in shunt reactors during low loads or while energizing long EHV lines
- Switching in shunt capacitors during high loads or low power factor loads
- use of series capacitors in long EHV transmission lines and distribution lines in case of load fluctuations
- Use of tap changing transformers in industries, substations, distribution substations
- use of static shunt compensation having shunt capacitors and thyristorized control for step-less control of reactive power
- Use of synchronous condensers in receiving end substations for reactive power compensation.

Unit 3- MECHANICAL DESIGN OF LINES

1. What is sag template? (May/June 2014) (Nov/Dec 2015) . (APRIL/MAY 2018)

A Sag Template is a very important tool with the help of which the position of towers on the Profile is decided so that they conform to the limitations of vertical and wind loads on any particular tower, and minimum clearances, required to be maintained between the line conductor to ground, telephone lines, buildings, streets, navigable canals, power lines, or any other object coming under or near the line.

2. What is meant by Sag? (Nov/Dec 13) (APR/MAY 2016)(NOV/DEC 2018)

The difference between points of supports and the lowest point on the conductor is called sag.

3. What is deviation tower? (May/June 2013)

It is the deviation from straight run and changes direction in a tower called deviation tower. It is depend upon the stress due to conductor weight and wind pressure.

4. Name any 2 factors affecting sag.(Nov/Dec 2012) (Nov/Dec 10)(Nov/Dec 2016)(April/May 2017)

The length of span

The working tensile stress.

5. What is meant by tower spotting?(Nov/Dec 2015)

6. Define String efficiency (Nov/Dec 10) Nov/Dec 2015)

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.

$$stringefficiency = \frac{voltageacrossstheinsulatorstring}{numberofdiscs \times voltageacrossthediscnearesttotheconductor}$$

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

7. What are the advantages of string insulators? (Nov/Dec 2011)

i. Cheaper than pin type insulators for voltage greater than 33 KV

ii. Number of disc can be inserted depending upon the voltage that flows.

iii. Failure in any one unit will not affect the entire string. Replacement can be done easily.

iv. More flexibility.

v. Conductor runs below the cross arm, so line conductors are less affected by lightening.

vi. Arrangements act as lightening arrestors.

8. What are the causes of failure of insulators? (April/May 2011)

Causes of failure of insulators are porosity, presence of impurities and cracks, puncture of insulator and flash over.

9. Give the importance of stay insulators.

i. In case of low voltage lines, it is necessary that the stays are to be insulated at a height of not less than 3 meters from ground.

ii. It is used to create insulation between pole and stay clamp.

iii. In case if the insulator breaks, then the stay wire will not fall on the ground.

10. A 1 km long single core cable has a core diameter of 2.5cm, insulation thickness of 1.25 cm and resistivity of the insulation is 4.5×10^4 ohms-cm. calculate the insulation resistance/km

$$R = \frac{\rho}{2\pi l} \ln \frac{D}{d}$$

$$t = \frac{D - d}{2}$$

$$1.25 = \frac{D - 2.5}{2}$$

$$D = 5\ cm$$

$$R = \frac{4.5 \times 10^4}{2\pi \times 100000} \ln \frac{5}{2.5}$$

$$R = 496\ Mohm$$

11. What are the various methods of improving string efficiency? (May/June 13)(Nov/Dec 2016)

i. By using larger cross arm
ii. By grading the insulator
iii. By using guard ring

12. Write down the expression for insulation resistance of a single core cable (Nov/Dec 13)

$R = \frac{\rho}{2\pi l} \ln \frac{R}{r}$ ohms

13. What is shackle Insulator? (May/June 2014)

When the low voltage transmission line meets a dead end or a corner or a sharp curve it is subjected to a greater tension. The insulators, which are used to relieve the low voltage line of excessive tension, are called shackle insulators.

14. Why are insulators used with overhead lines? (Nov/Dec 14)(NOV/DEC 2018)

Insulators are used to support the conductors and withstand both the normal operating voltage and surges due to switching and lightning. It also provide necessary insulation between line conductors, tower and thus prevent any leakage from conductors to earth.

15. What are the test performed on the insulators?(APR/MAY 2016)

According to the British Standard, the electrical insulator must undergothe following tests

1. Flashover tests of insulator
2. Performance tests
3. Routine tests

16. Specify the different types of insulators. (April/May 2017)

1. Pin Insulator 2. Suspension Insulator 3. Strain Insulator In addition to that there are other two types of electrical insulator available mainly for low voltage application, e.i. Stay Insulator and Shackle Insulator

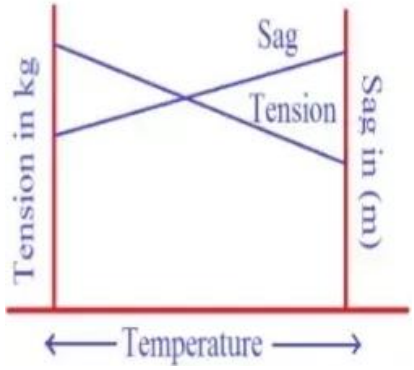
17. How does grading improves string efficiency? (Nov/Dec 2013)

This method uniforms the potential distribution across each units in insulator strings. Thereby string efficiency improves.

18. What is meant by stringing chart(APR/MAY 2016)

Stringing chart is basically a graph between Sag, Tension with Temperature. As we want low Tension and minimum sag in our conductor but that is not possible as sag is inversely proportional to tension. It

is because low sag means a tight wire and high tension whereas a low tension means a loose wire and increased sag. Therefore, we make compromise between two but if the case of temperature is considered and we draw graph then that graph is called Stringing chart



As Temperature increases then sag will increase but sag is inversely proportional to Tension so Tension will decrease.

19. Give the significance of a stringing chart. (NOV/DEC 2017)

a. For finding the sag in the conductor
b. In the design of insulator string
c. In the design of tower
d. To find the distance between the towers

20. State the advantages of suspension type insulators. (APRIL/MAY 2018)

(*i*) Suspension type insulators are cheaper than pin type insulators for voltages beyond 33 kV.

(*ii*) Each unit or disc of suspension type insulator is designed for low voltage, usually 11 kV. Depending upon the working voltage, the desired number of discs can be connected in series.

(*iii*) If any one disc is damaged, the whole string does not become useless because the damaged disc can be replaced by the sound one.

(*iv*)The suspension arrangement provides greater flexibility to the line. The connection at the cross arm is such that insulator string is free to swing in any direction and can take up the position where mechanical stresses are minimum.

(*v*) In case of increased demand on the transmission line, it is found more satisfactory to supply the greater demand by raising the line voltage than to provide another set of conductors. The additional insulation required for the raised voltage can be easily obtained in the suspension arrangement by adding the desired number of discs.

(*vi*)The suspension type insulators are generally used with steel towers. As the conductors run below the earthed cross-arm of the tower, therefore, this arrangement provides partial protection from lightning.

Unit 4- UNDER GROUND CABLES

1. What is the necessity of grading of an underground cable?(Nov/Dec 10)

Grading of the underground cable is done to achieve uniform electrostatic stress in the dielectric of cable.

The following are the two main methods of grading of cables:

i. Capacitance grading
ii. Intersheath grading

2. List the four main insulating materials used in cables?(May/June 13)(Nov/Dec 2016)

i. PVC
ii. Rubber
iii. Impregnated paper
iv. Polythene

3. What are the effects of grading of cables? List out methods of grading also.(Nov/Dec 2011)(April/May 2017)

Uniform electrostatic stress in the dielectric of cable is achieved by grading of cables.

Methods of grading

i. Capacitance grading
ii. Intersheath grading

4. List out the four main properties of insulating materials for cables.What are the desirable properties of insulator? (NOV/DEC 2017) . (APRIL/MAY 2018)

i. High insulation resistance to avoid leakage current
ii. High dielectric strength to avoid electrical breakdown of the cable
iii. High mechanical strength to withstand the mechanical handling of cables
iv. Non-hygroscopic i.e) it should mot absorb moisture from air or soil.
v. Non inflammable
vi. Unaffected by acids and alkalies

5. Show that the insulation resistance of cable is inversely proportional to its length. (NOV/DEC 2018)

Derivation:

Let,

r be the radius of the conductor

R be the radius of metallic sheath

x be the radius of annulus

l be the length of cable

ρ be the resistivity of insulation

Insulation resistance $dR_{ins} = \frac{\rho\, dx}{2\pi x}$ ohms/m

Insulation resistance per meter length is,

$$R_{ins} = \int_r^R \frac{\rho\, dx}{2\pi x} = \frac{\rho}{2\pi}\int_r^R \frac{dx}{x}$$

$$= \frac{\rho}{2\pi}[\ln R - \ln r]$$

$$= \frac{\rho}{2\pi} \ln \frac{R}{r} \quad \text{ohms / m}$$

If the cable has length of l meters, then

$$R = \frac{\rho}{2\pi l} \ln \frac{R}{r} \text{ ohms}$$

6. Give the classification of cable for 1ϕ and 3ϕ Service with operating voltages. (NOV/DEC 2018)

i. Low tension cables - upto 1000 V
ii. High tension cables - upto 11000 V
iii. Super tension cables - from 22 KV- 33 KV
iv. Extra High tension cables - from 33 KV- 66 KV
v. Extra super tension cables - beyond 132 KV

7. What is the function of sheath in a cables? (May/June 2014)

The sheath does not allow the moisture to enter and protects the cable from all external influences like chemical or electrochemical attack fire etc.

8. What is meant by serving of a cable? (May/June 2017)

A layer of fibrous material permitted with waterproof compound applied to the exterior of the cable is called serving of a cable.

9. What is meant by dielectric stress in a cable? (May/June 2014)

Under Operating Conditions, the insulation of a cable is subjected to electrostatic force known as dielectric stress.

10. What are the factors to be considered while selecting a cable for a particular service? Nov/Dec 14)

- Materials,
- Working Voltage,
- Load Current,
- Short circuit current,
- Load factor,
- Frequency,
- Acceptable Voltage Drop,
- Economics

11. What is the main purpose of armouring? (APR/MAY 2015)

The main purpose of armour is to provide mechanical protection, although it can also provide part of the earth fault path. For multi-core cables steel wire armour is most often used.

12. What are the materials mainly used in bus bars? (APR/MAY 2015)

- Alluminium busar,
- Copper busbar
- Alluminium coated copper busbar or tinned busbar.

13. Define Grading of Cables. (Nov/Dec 12)

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

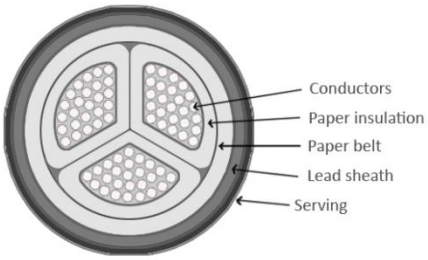
14. Classify the cables used for three phase service(APR/MAY 2016)

The following types of cables are generally used for 3-phase service :

1. Belted cables — upto 11 kV
2. Screened cables — from 22 kV to 66 kV
3. Pressure cables — beyond 66 kV.

15. What is a belted-Cable? (NOV/DEC 2017)

This provides flexibility as well as a circular shape. As we discussed earlier (in Construction of Cables), the jute layer is then covered by a metallic sheath and armouring for protection. One particular speciality of this cable is that its shape may not be perfectly circular. It is kept non-circular to use the available space more effectively.



There are some limitations of such construction. Since the electric field is tangential, the insulation provided is stressed. As a result, the dielectric strength falls over time. Hence, such construction isn't preferred for voltage levels above 11 kV.

16. List the advantages of polythene insulators? (NOV/DEC 2018)

They possess very good strength and toughness. They possess good shock absorption capacity. Advantages of plastic are corrosion resistant and chemically inert. They have low thermal expansion of co-efficient and possess good thermal and electrical insulating property

18.State the limitation of solid type cables. How are these overcome in pressure cables? (May/June 2012)

For voltages beyond 66KV, solid type cables are unreliable, because there is no danger of breakdown of insulation due to the presence of voids.

But in pressure cables, voids are eliminated by increasing the pressure of the compound by using oil, gas etc.

19.Why cables are not used for long distance transmission? (May/June 2016)

Cables are not used for long distance transmissions due to their large charging currents.

20. In what way Al sheaths are superior to lead sheaths? (May/June 2015)

Al sheaths are smaller in weight, high mechanical strength , greater conducyivity, cheap,easy to manufacture and install, withstand the required gas pressure without reinforcement.

Unit 5- DISTRIBUTION SYSTEMS

1. List the various substation equipments. (May/June 2017)

i. Transformer
ii. Bus bars
iii. Insulators
iv. Isolators and fuses
v. Circuit breaker
vi. Relays
vii. Lightening arresters.

2. What are the various methods of earthling in substations?(Nov/Dec 2011) (April/May 2017)

i. Solid grounding
ii. Resistance grounding
iii. Reactance grounding
iv. Resonant grounding

3. Mention the advantages of outdoor substation over indoor substation. (April/May 2011)

i. Time required for erection is less
ii. Future extension is easy
iii. Fault location is easy
iv. Capital cost is low

4. What are the objectives of earthling? (Nov/Dec 2013) (April/May 2011)(Nov/Dec 2016)

Due to defective electrical apparatus and some other reasons, electricity causes electric shock hazards for human being and animals. Grounding is of major concern to increase the reliability of supply service, as it provides stability of voltage conditions, prevents excessive voltage peaks during the disturbances. Grounding is also a measure of protection against lightening.

5. Why are transmission lines 3 phase 3 wire circuits while distribution lines are 3 phase 4 wire circuits? (Nov/Dec 10)

Transmission lines 3 phase 3 wire circuits while distribution lines are 3 phase 4 wire circuits because transmission line consists of three conductors which represents the phases R, Y, and B whereas distribution line requires neutral in addition with three phases to supply the 1 phase loads of domestic and commercial consumers.

6. Classify the types of substation depending upon its physical features. (May/June 2014)

i. Indoor substation
ii. Outdoor substation
iii. Underground substation
iv. Pole mounted substation.

7. What is substation? (May/June 2014)

The assembly of apparatus used to change some characteristic (eg: voltage , A.C to D.C frequency power factor etc) of electric supply is called a substation.

8. What is bus bar? What are the materials mainly used for Busbar?(APR/MAY 2015)

Busbar is a conductor to which a number of circuits are connected.

The materials used in bus bars are,

Copper and aluminium

9. **What are the major equipments of a substation?(May/June 2014)(Nov/Dec 10)(NOV/DEC 2017)**

- Transformers, Circuit Breakers,
- Isolators,Current and Potential transformers,
- Bus bars,Protective relays,
- Lightning arresters,Earthing Switch,
- Shunt Capacitors,Station Battery and Charging Equipment.

10. **Enumerate the various methods of neutral grounding.(May/June 2014)**

- solid grounding, resistance grounding
- reactance grounding, resonant grounding

11. **What is the purpose of terminal and through sub-stations in the power system? (Nov/Dec 14)**

A terminal sub-station is one in which the line supplying to the substation terminates or ends. It may be located at the end of the main line or it may be situated at a point away from main line route.

A through sub-station is one in which the incoming line passes 'through' at the same voltage. A tapping is generally taken from the line to feed to the transformer to reduce the voltage to the desired level.

12. **What is the function of isolators? (Nov/Dec 13)**

It is used to disconnect a part of the system for general maintenance and repairs.

13. **Mention any 4 bus bar schemes used in substation. (May/June 13)**

- Single bus bar arrangements
- Single bus bar arrangements with sectionalism
- Double bus bar arrangements
- Double bus bar arrangements with sectionalism

14. **List type of Substations. (Nov/Dec 12)(APR/MAY 2015)**

- Transformer Substations, Switching Substations
- Industrial Substations, Indoor Substations
- Outdoor Substations, Underground Substations
- Pole-mounted Substations

15. **List out the basic types of FACTS controllers. (April/May 2011)**

i.Series controller
ii. Shunt controller
iii. Combined series series controller
iv. Combined series shunt controller

16. **What are the various types of HVDC systems? (May/June 2013)**

i.Monopolar
ii. Bipolar
iii. Homopolar
iv. Back to back coup[ling
v.Multi terminal HVDC system

17. Differentiate a primary distribution and secondary distribution with the help of a diagram.

S.NO	PRIMARY DISTRIBUTION	SECONDARY DISTRIBUTION
1	Also called high voltage distribution	Also called low voltage distribution
2	Uses 3φ 3 wire system	Uses 3φ 4 wire system
3	Voltage level is 6.6 KV	Voltage level is 230 V for 1φ and 415 V for 3φ

18. What are the applications of HVDC transmission system?(Nov/Dec2016)

i. Long distance bulk power transmission

ii. Underground or under water cables

iii. Asynchronous interconnection of AC system operating at different frequencies or where independent control of system is desired

iv. Control and stabilization of power flows in AC ties in an integrated power system.

19. State the various devices used in FACTS. (May/June 2018)

i. Static synchronous compensator(STATCOM)

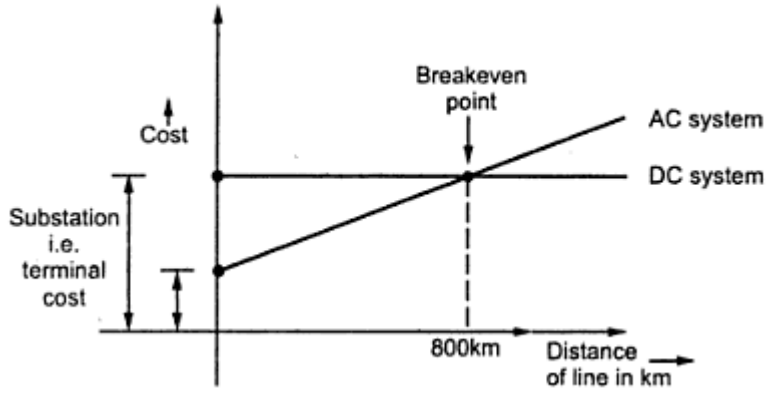
ii. Static synchronous generator

iii. Static VAR compensator

iv. Thyristor switched capacitor

20. Define breakeven distance in HVDC transmission.(May/June 2017)

A graph is plotted between the cost and distance of line in Km by taking cost along y axis and line in Km along x axis.The curves for AC and DC transmission intersect each other at a point called breakeven point. Distance measured till breakeven point is called breakeven distance.



21. What is meant by STATCOM? (May/June 2013)

It is shunt connected static VAR compensator whose capacitive or inductive output current can be controlled independently of the AC system voltage.

22. Explain the term regional grid.(Nov/Dec-16)

In order to achieve economy, reliability and continuity in the supply individual power systems that are generating electrical power are arranged in the form of electrically connected areas called regional grid.

23. State the advantages of EHVAC transmission system .(Nov/Dec-16)

i. With the increase in transmission voltage, the transmission efficiency increases for a given amount of power to be transmitted over a given

ii. distance

iii. Voltage regulation is improved, because of reduction in line losses

iv. The volume of conductor material decreases, being inversely proportional to the square of transmission voltage

24. Mention the terminal equipments in HVDC system. (Nov/Dec-16)

i. DC line inductors.

ii. Harmonic filter on DC side

iii. Reactive power source

iv. Harmonic filter on AC side

v. Ground electrodes

25. What is the necessity of FACTS? What are the objectives of FACTS? (APR/MAY 2016) (NOV/DEC 2017)

The FACTS technology makes use of power electronic promotes the control of transmission line. It also increase load on the line upto the thermal limits without having compromise with the reliability.

26. How does a.c. distribution differ from the d.c distribution? (Nov/Dec 14)

In case of ac distribution, The power generated is always in AC. It is then stepped up and down appropriately Then distributed at around 11kV and finally 440V (3 phase) for household usage. The frequency is maintained at around 50 Hertz. Not much of power conversion is required here.

In case of DC, the generated voltage 11kV is stepped up and converted to high voltage DC. Load in this dc distribution act at a particular point and also the same load may act at both the end of the lines.

27. What is a feeder/Distributor? (May/June 13) (Nov/Dec2015)(Nov/Dec2016)

Feeder is a conductor which connects the substation or localized generating station to the area where power is to be distributed.

28. What is ring main distribution? (Nov/Dec 2012) (April/May 2017)

A ring distributor is a distributor which is arranged to form a closed circuit and is fed at one or more than one point.

Advantages are,

i. Less voltage fluctuations at consumer's terminals. Less copper is required

ii. Each part of the ring carries less current than in radial system.

29. Distinguish between radial and ring main distribution. .(Nov/Dec-15)

S.NO	RADIAL DISTRIBUTION	RING MAIN DISTRIBUTION
1	Fed at one end only	Fed at one or more points
2	More voltage fluctuation at far end	Less voltage fluctuation at consumers terminals
3	Less reliable	More reliable
4	Straight line distributor with both ends	Forms a closed loop.

30. What are the advantages of a 3 wire dc distribution system over a 2 wire dc distribution system? (Nov/Dec-12)

If 3 wire system is used to transmit the same amount of power over the same distance with same efficiency with same consumer voltage we require 0.3125 times copper as required in 2 wire system.

31. List out the advantages of high voltage AC transmission.
(Nov/Dec 2012)(APR/MAY 2016)

i. Reduced line losses
ii. Reduced in current
iii. Reduction in volume of conductor material required
iv. Decrease in voltage drop and increase in transmission efficiency
v. Improvement of voltage regulation
vi. Increased power handling capacity

32. Mention the demerits of HVDC transmission. (Nov/Dec 10)

i. The dc voltages cannot be stepped up for transmission of power at high voltages.
ii. The dc switches and circuit breakers have their own limitations.
iii. Power transmission with HVDC is not economical if the length of transmission line is less than 500km
iv. Considerable reactive power is required by converter station.
v. Maintenance of insulator is more.

33. State Kelvin's Law for size of transmission conductor.(Nov/Dec 14)

The annual expenditure on the variable part of the transmission system should be equal to the annual cost of energy wasted in the conductor used in that system.

34. What is gas insulated substation? (APRIL/MAY 2018)

A gas-insulated substation (GIS) uses a superior dielectric gas, SF6, at moderate pressure for phase-tophase and phase-to-ground insulation. The high voltage conductors, circuit breaker interrupters, switches, current transformers, and voltage transformers are in SF6 gas inside grounded metal enclosures.

35. What,are the advantages of adopting EHV/UHV for transmission of AC electric power? (NOV/DEC 2018)

- Flexibility for Future System Growth:
- Increase in Transmission Capacity of the Line:
- Possibility of Interconnections of Power Systems:
- Increase of Surge Impedance Loading:
- Reduction in Right-Of-Way:

36. Why galvanized steel wire is not suitable for EHT lines for the purpose of transmitting large amounts of power over long distance? (NOV/DEC 2018)

- Because of Poor conductivity
- High internal reactance & eddy current & hysterisis