

EE1252 Transmission and Distribution

Unit1

1. Why all transmission and distribution systems are 3 phase systems?
A 3 phase a.c circuit using the same size conductors as the single phase circuit can carry three times the power which can be carried by a 1 phase circuit and uses 3 conductors for the 2 phases and one conductor for the neutral. Thus a 3 phase circuit is more economical than a 1 phase circuit in terms of initial cost as well as the losses. Therefore all transmission and distribution systems are 3 phase systems.
2. Why the transmission systems are mostly overhead systems?
Because of the cost consideration, the transmission systems are mostly overhead systems.
3. Why all overhead lines use ACSR conductors?
ACSR conductors comprises of hard drawn aluminium wires stranded around a core of single or multiple strand galvanized steel wire. They provides the necessary conductivity while the steel provides the necessary mechanical strength. Has less corona loss. The breaking load is high and has less weight.
4. Why transmission lines are 3 phase 3 wire circuits while distribution lines are 3 phase 4 wire circuits?
A Balanced 3 phase circuit does not require the neutral conductor, as the instantaneous sum of the 3 line currents are zero. Therefore the transmission lines and feeders are 3 phase 3 wire circuits. The distributors are 3 phase 4 wire circuits because a neutral wire is necessary to supply the 1 phase loads of domestic and commercial consumers.
5. Why overhead line conductors are invariably stranded?
They are stranded to make them flexible during erection and while in service.

6. Stat the advantages of interconnected systems.
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.
7. What is a ring distributor?
A ring distributor is a distributor which is arranged to form a closed circuit and is fed at one or more than one point.
8. State any two advantages of ring main system.
Less voltage fluctuations at consumer's terminals. Less copper is required as each part of the ring carries less current than in radial system.

9. Mention the disadvantages of a 3 wire system

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

10. What are the advantages of a 3 wire dc distribution system over a 2 wire dc distribution system?

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.

11. Mention the differences between 3 wire and 3 phase 4 wire distribution system?

i)3 phase 3 wire is employed for balanced loads, but 3 phase 4 wire is employed for unbalanced loads.

ii)3 phase 3 wire is used for transmission but 3 phase 4 wire is used for distribution of power to consumers.

12. State kelvin's law.

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.

13. State any two limitations of kelvin's law.

It is difficult to estimate accurately the annual charge on the capital outlay. It does not give the exact economical size of the conductor.

14. Define resistance of the transmission line.

It is defined as the loop resistance per unit length of the line in a single phase system. In 3 phase system it is defined as the resistance per phase.

15.Mention the demerits of HVDC transmission.

- i. Electric power cannot be generated at high dc voltages.
- ii. The dc voltages cannot be stepped up for transmission of power at high voltages.
- iii. The dc switches and circuit breakers have their own limitations.

16. What are the advantages of high voltage ac transmission.

The power can be generated at high voltages.

The maintenance of ac substation is easy and cheaper.

17. Mention the disadvantages of high voltage ac transmission.

An ac line requires more copper than a dc line.

The construction of an ac line is more complicated than a dc transmission line.

Due to skin effect in the ac system the effective resistance of the line is increased.

18. Mention the limitations of using very high transmission voltage.

The increased cost of insulating the conductor.

The increased cost of transformers, switch gears and other terminal apparatus.

19. Mention the terminal equipments necessary in HVDC system.

Converters, mercury arc valves and thyristors.

20. Why HVDC line do not require any reactive power compensation ?

Due to absence of charging currents .

21. Mention the equipments that supply reactive power in HVDC converter stations ?

AC filters

Static shunt capacitors

Synchronous condensers

Static VAR compensators .

22. Why dc transmission is economical and preferable over ac transmission for large distances only ?

Because with larger distances, the saving in cost of dc overhead lines become greater than the additional expenditure on terminal equipment .

23. Why is voltage regulation better in case of dc transmission ?

Because of absence of inductance in dc systems .

24. What are the advantages of adopting EHV/UHV for transmission of ac electric power?

-Reduced line losses

-High transmission efficiency

-Improved voltage regulation

-Reduced conductor material requirement

-Flexibility for future system growth

- increase in transmission capacity of the line
- increase of SIL .

25. Mention the problems associated with an EHV transmission ?

The problems associated with EHV transmission are corona loss and radio interference, requirements of heavy supporting structures erection difficulties and insulation requirements .

26. What for series and shunt compensation provided in EHV lines ?

Series compensation is provided to reduce the series reactance of the line so as to improve stability, voltage regulation and transmission efficiency. Shunt compensation is provided to reduce the line susceptance so as to improve the voltage regulation under light load condition .

27. What is the voltage that has been selected for HVDC transmission ?

± 500 KV .

28. Define an electric power supply system?

The system of generation, transmission and distribution of electrical power is called the electrical power system .

29. What are service mains?

Service mains are conductors which connect the consumers terminals to the distributor.

30. What is the usable voltage for secondary distribution ?

415 / 40 V (415 volts for 3-phase loads and 240 volts for 1-phase loads)

31. Why galvanized steel wire is not suitable for EHT lines for the purpose of transmitting large amounts of power over long distance?

- because of Poor conductivity
- High internal reactance & eddy current & hysteresis

31. Mention the transmission voltages that are used in India?

33/66/110/132/220/400/765 KV.
765KV is EHV.

32. On what basis the conductor size is determined for transmission lines upto 220 KV?

--is determined on the basis of its current carrying capacity.

33. On what basis the conductor size of EHV line is determined?

--is decided on the basis of corona

34. Mention the sources of audible noise generation in EHV transmission systems?

Corona
Humming of transformers
Cooking Systems

Mechanical and Electrical auxiliaries

35. Mention the material universally employed for overhead transmission line?

ASCR (Aluminium Conductor Steel Reinforced)

36. What is the economical value of span for 400kv transmission line ?

350-400m.

Unit2

37. Define inductance of a line.

It is defined as the loop inductance per unit length of the line .Its unit is henrys per meter.

38. Define capacitance of a line.

It is defined as shunt capacitance between the two wires per unit line length. Its unit is farads per meter.

39. What is skin effect?

The steady current when flowing through the conductor ,does not distribute uniformly, rather it has the tendency to concentrate near the surface of the conductor. This phenomenon is called skin effect.

40. Why skin effect is absent in dc system?

The steady current when flowing through a conductor distributes itself uniformly over the whole cross section of the conductor .That is why skin effect is absent in dc system.

41. What is the effect of skin effect on the resistance of the line?

Due to skin effect the effective area of cross section of the conductor through which current flow is reduced. Hence the resistance of the line is increased when ac current is flowing.

42. On what factors the skin effect depend?

Nature of the material, Diameter of the wire , Frequency and shape of the wire.

43. Define symmetrical spacing.

In 3 phase system when the line conductors are equidistant from each other then it is called symmetrical spacing.

44. What is the necessity for a double circuit line?

To reduce the inductance per phase and to increase the efficiency.

45. Mention the factors governing the inductance of a line.

Radius of the conductor and the spacing between the conductors.

46. Define a neutral plane.

It is a plane where electric field intensity and potential is zero.

47. Define proximity effect.

The alternating magnetic flux in a conductor caused by the current flowing in a neighbouring 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.

48. What is the effect of proximity effect?

It results in the non uniform distribution of current in the cross section, and the increase of resistance.

49. What is a composite conductor?

A conductor which operates at high voltages and composed of 2 or more subconductors and run electrically in parallel are called composite conductors.

50. What is a bundle conductor?

It is a conductor made up of 2 or more sub conductors and is used as one phase conductors.

51. Mention the advantages of using bundled conductors.

Reduced reactance, reduced voltage gradient , reduced corona loss .reduced interference

52. What is meant by transposition of line conductors?

Transposition means changing the positions of the three phases on the line supports twice over the total length of the line .the line conductors in practice ,are so transposed that each of the three possible arrangements of conductors exit for one-third of the total length of the line .

53. Define bundled conductors?

The use of more than one conductor per phase is called bundled conductors.

54. What is skin effect?

The phenomenon of concentration of an ac current near the surface of the conductor is known as skin effect.

55. On what factors does the skin effect depend?

The skin effect depends upon the

1, type of the material

2, frequency of the current

3, diameter of conductor & shape of conductor.

It increases with the increase of cross-section, permeability and supply frequency.

56. Define voltage regulation.

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

..% voltage regulation = $\frac{(V_s - V_r)}{V_r} \times 100$

57. where V_s is the voltage at the sending end

V_r is the receiving end voltage.

58. Define transmission efficiency.

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

59. Define Ferranti effect .

The phenomenon of rise in voltage at the receiving end of the open circuited or lightly loaded line is called the Ferranti effect .

60. What are the units of ABCD (generalised) constants of a transmission line ?

A and D are dimensionless

B is in ohms and

C is in Siemens (mhos)

61. Mention the range of surge impedance in underground cables .

40-60 ohms

62. Mention the range of surge impedance in overhead transmission lines .

400-600 ohms

Unit3

63. What is corona?

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

64. Mention the factors affecting corona.

Atmosphere, conductor size, spacing between conductors and line voltage.

62. Define critical disruptive voltage.

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

65. Define visual critical voltage.

It is the minimum phase voltage at which corona appears all along the line conductors.

66. State any two merits of corona.

Reduces the effects of transients produced by surges. System performance is improved.

67. Give the two demerits of corona.

The transmission efficiency is affected. Corrosion occurs.

68. Mention the methods of reducing corona effect.

By increasing the conductor size and conductor spacing.

69. Why ACSR conductors are used in lines?

If the size of the conductor is larger corona effects are reduced and reduces the proximity effect. Hence they are used in lines.

70. Define medium lines.

Lines having length between 60 and 150 km and line voltages between 20 and 100kv are called medium lines.

71. Define short lines.

Lines having lengths below 60km and voltages below 20kv are called short lines.

72. Mention the limitations of end condenser method.

This over estimates the effects of line capacitance
.It is assumed to be lumped or concentrated.

73.Explain the term voltage stability.

The ability of the system to maintain the voltage level within its acceptable limits is called as voltage stability.

74.Differentiate between voltage stability and rotor angle stability.

Voltage stability:

- It means load stability.
- It is mainly related to reactive power transfer.
- Here problems arise mainly in the event of faults.

Rotor angle stability:

- It means basically generator stability.
- It is mainly interlinked to real power transfer.
- Here problems arise during and after faults.

75.Define surge impedance.

The characteristic impedance of a lossless line is called as surge impedance.

$$Z_c = \sqrt{z/y} = \sqrt{L/C} \text{ ohm.}$$

76.What is surge impedance loading?

A line is said to be operating at surge impedance load (natural load) when it is terminated by a resistance equal to characteristic impedance.

Receiving end current under the condition of surge impedance loading is

$$I_r = V_r / (\sqrt{3} Z_c) \text{ where } V_r \text{ is the receiving end line voltage.}$$

$$\text{And } Z_c = \sqrt{L/C}.$$

77.Mention the significance of Surge impedance loading.

--The voltage and current are equal and are in phase at all points along the line.

--No reactive power is generated or absorbed at the line ends.

--The total reactive power absorbed by line inductance is equal to the total reactive power generated by line capacitance.

$$I^2 \omega L = V^2 \omega C$$

$$Z = V/I = \sqrt{L/C}$$

78.What is shunt compensation ?

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

79.Define a synchronous compensator (condenser)?

Synchronous compensator is a synchronous motor with no mechanical output .When it is under excited it operates at lagging p.f (ie it delivers vars) .Thus it operates both as a shunt capacitor and as a shunt reactor .

80.Mention any two advantages of series compensation
-improves system stability .
-are generally self regulatory and requires little or no control equipment

81.Mention any two advantages of SVS .(Static Var System)
Provides fast control over temporary over voltages.
Provides a better control of voltage profile .

82.State any two comparisons between series compensation and shunt compensation.
-Series compensation is cheaper than SVS .
-Losses are lower than in SVS .

83.Why series compensation is used in long series ?
-to increase transmission capacity
-to improve system stability .
-to obtain correct load division between parallel circuits .

84.Mention the components used in series compensation ?
Series capacitors
Spark gap protection
Metal oxide resistor (for protection)
Current limiting reactor
Bypass switch
Control & protection equipment .

85.Mention the components used in static var compensator .
Saturated reactor
Thyristor controlled reactor –fired capacitor (TCR –FC)
Thyristor switched capacitor – thyristor controlled reactor (TSC –TCR)
Harmonic filters.

86.Give any two reasons to minimize the reactive power transfer in lines .
-leads to voltage stability.
-results in greater real and reactive losses .

87.List the four parameters by which the performance of transmission lines are governed .
Series resistance
Series inductance
Series capacitance
Series conductance.

88.Define Ferranti effect .
Under no load or lightly loaded conditions ,the capacitance associated with the line generates more reactive power than the reactive power which is absorbed & hence the

voltage at the receiving end is found to be greater than at the sending end . This is called as Ferranti effect .ie $V_r > V_s$.

Unit4

89. Why cables are not used for long distance transmission?

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

90. Mention the 3 main parts of the cable?

Conductor ,dielectric ,sheath

91. What is the function of conductor?

Conductor provides the conducting path for the current.

92. What is the purpose of insulation in a cable?

The insulation or dielectric withstands the service voltage and isolates the conductor with other objects.

93. What is the function of sheath in a cables?

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

94. Mention the conductor materials in cables?

Copper , Aluminium

95. What is the purpose of stranding of conductors?

Stranding increases the resistance of the cable .It has flexibility.

96. Define the segmental conductors.

The stranded wires which are compacted by the rollers to minimize the air spaces between the individual wires are called segmented conductors .Here the conductor size is reduced for a given conductance.

97. State the properties of insulating materials.

It should have high insulation resistance ,high dielectric strength ,good mechanical properties ,non-hygroscopic, capable of being operated at high temperatures ,low thermal resistance and low power factor.

98. Mention the commonly used power cables.

Impregnated paper, Polyvinyl chloride, polyethene

99. Mention the advantages of pvc over paper insulated cables.

Reduced cost and weight, Insulation is resistant to water, Simplified jointing, Increased flexibility No plumbing required.

100. State the merits of paper insulated cables.

High current carrying capacity ,long life and greater reliability

101. Where polythene cables are used?

-being non-hygroscopic used in cables for submarines and damp soil.
- being lighter used as aerial cables for vertical installations.

102. State the advantages of polythene insulators.

They are non-hygroscopic, light in weight, low dielectric constant, low loss factor and low thermal resistance.

103. By what materials cable sheaths are made?

Lead sheaths and Aluminium sheaths.

104. In what way Al sheaths are superior to lead sheaths?
Al sheaths are smaller in weight, high mechanical strength, greater conductivity, cheap, easy to manufacture and install, withstand the required gas pressure without reinforcement.
105. Where CSA sheath is used in cables?
Corrugated seamless aluminium sheath is used in high voltage oil filled cables and telephone lines.
106. Why it is used?
It is used because it is very flexible and easily by repeated bending the sheath is not distorted and it is not damaged. It has lesser weight and reduced thickness.
107. Why protective covering is done in cables?
To protect the cables from mechanical damage, corrosion and electrolytic action when laid direct in the ground the protective covering is made.
108. By what material protective covering is made?
Bitumen & Bituminized materials, pvc and layers of fibrous materials.
109. What is meant by serving of a cable?
Layers of fibrous material permitted with waterproof compound applied to the exterior of the cable is called serving of a cable.
110. Why armouring is done in the cables?
To protect the sheath from mechanical damage.
111. Why armouring is not done in single core cables?
The presence of magnetic material within the alternating magnetic field of a single core cable produces excessive losses. Hence single core cables are left unarmoured with non-magnetic materials like tin-bronze or silicon-bronze tapes or wires.
112. Why Al is used as an armour material?
It has non-magnetic properties, high conductivity and mechanical strength.
113. What is meant by grading of cables?
The method of equalizing the stress in the dielectric of the cable is called the grading of cables.
114. Mention the methods of cables.
Capacitance grading and inter sheath grading.
115. Why the capacitance of the cable is very high than the capacitance of the overhead lines?
The distance between the conductors are small. The distance between the cores and the earthed sheath is also small. The permittivity of the cable insulation is 3 to 5 times greater than that of air insulation.
116. Write the expression of the capacitance of a single core cable.

$$C = \frac{q}{v} = \frac{2\pi\epsilon}{\ln(R/r)}$$

2. ----- F/m

3. $\ln(R/r)$

117. What is meant by charging current of a cable?

The capacitance of a cable determines the charging current. The charging current restricts the use of cables on EHV lines. The current carrying capacity of an a.c cable is also reduced by the charging current.

118. Why power loss occurs in the dielectric of a cable?

- due to conductivity of insulation
- Dielectric hysteresis or dielectric absorption.
- Ionization or corona

119. Mention the methods of laying the cables.

Direct laying , draw in system and solid system

120. Mention the advantages of direct laying of cables.

It is simple and cheaper method. It gives the best conditions for dissipating the heat generated in the cables.

121. State any 2 disadvantages of direct laying method.

Localisation of fault is difficult . It cannot be used in congested areas where excavation is inconvenient.

122. Mention the disadvantages of pressure cables.

The cost of the pressure tube is high.

123. Mention the types of gas pressure cables/

External and internal pressure cables.

124. What are the types of oil filled cables?

Single core conductor channel cables , Sheath channel cables and 3 core filler space channel.

125. What are the types of pressure cables?

Oil filled cables and gas pressure cables.

126. What is the operating range of pressure cables?

It is greater than 66 kv.

127. What are the advantages of SL cables over H- type cables?

The possibility of core to core breakdown decreases to a large extent. Bending of cables becomes easy owing to no overall lead sheath.

128. Mention the disadvantages of oil filled cables.

Expensive , laying and maintenance of cables is quite complicated.

129. What are the types of screened cables?

H type and SL type cables.

130. Why the working voltage level of belted cables is limited to 22 kv?

It is limited because beyond 22 kv tangential stresses acting along the layers of paper insulation set up large current. This current causes local heating resulting in the risk of breakdown insulation at any moment.

131. Up to what voltage range are belted cables used?

Up to 11 kv. In some extra ordinary cases they are used upto even 22 kv.

132. What are the different types of cables that are generally used for 3 phase service?

Belted cable , Screened cables and pressure cables.

Unit5

133. Define sag of a line.

The difference in level between the points of supports and the lowest point of the conductor is called as sag.

134. Mention the factors that affect sag in the transmission line.

Weight of the conductor, length of the span , working tensile strength and the temperature.

135. What is the reason for the sag in the transmission line?

While erecting the line , if the conductors are stretched too much between supports then there prevails an excessive tension on the line which may break the conductor. In order to have safe tension in the conductor a sag in the line is allowed.

136. How the capacitance effect is taken into account in a long line?

They have sufficient length and operate at voltage higher than 100 kv the effects of capacitance cannot be neglected. Therefore in order to obtain reasonable accuracy in long lines , the capacitance effects are taken.

137. Mention the limitations of nominal T and pi methods in the line problems.

Generally the capacitance is uniformly distributed over the entire length of the line. But for easy calculations the capacitance is concentrated at one or two points. Due to these effects there are error in the calculations.

138. What are limitations of end condenser method.

There is considerable error in calculations because the distributed capacitance has been assumed to be lumped or concentrated.

This method over estimates the effects of the line capacitance.

145. What is end condenser method?

It is a method used for obtaining the performance calculations of medium lines. Here the capacitance of the line is lumped or concentrated at the receiving end.

139. What is power circle diagram?

It is a diagram drawn for the transmission lines network involving the generalized circuit constants and the sending end and receiving end voltage.

140. What are the voltage regulating equipments used in transmission system?

Synchronous motors, tap changing transformers, series and shunt capacitors booster transformers, compound generators and induction regulator.

141. Mention the methods used for voltage control of lines

Tap changing auto-transformer, booster transformer, excitation control and induction regulator.

142. What is sending end power circle diagram?

The circle drawn with sending end true and reactive power as the horizontal and vertical co-ordinates are called sending end power circle diagram.

143. What is receiving end power circle diagram?

The circle drawn with receiving end values are called receiving end power circle diagram.

144. Mention 2 significance of neutral grounding

*the system voltage during the earth fault depends on neutral earthing.

*is provided for the protection against arcing grounds, unbalanced voltages with respect to earth, protection from lightning.

145. what is neutral grounding.

Connecting the neutral or star point of any electrical equipment(generator, transformer etc) to earth.

146. define coefficient of earthing.

$$= (\text{highest rms voltage of healthy line to earth}) / (\text{line to line rms voltage}) * 100$$

147. define resonant frequency

-is a reactance earthing with selected value of reactance to match with the line to ground capacitance.

-is earthing through a reactance of such a value that power frequency current in neutral to ground connection is almost opposite to the power frequency capacitive current between un faulted line to earth.

148. mention 2 disadvantages of ungrounded neutral

occurrence of insulation breakdown leading to the heavy phase to phase fault condition.

-system cannot be protected from earth fault.

-voltages due to lightning surges do not find path to earth.

149. mention two advantages of neutral grounding.

-arcing grounds are eliminated.

-voltages of healthy phases with respect to earth do not increase to $3^{0.5}$ times with normal values.

150. name the various types of grounding.

-solid grounding

-resistance grounding

-reactance grounding

-resonant grounding

151. give the response of resistance for earth driven rods.

$$R = \rho / 2\pi l * \ln(4l/d)$$

Where

l – length of the rod

d – diameter of the rod

resistivity of the rod

152. for the uniformly current carrying ground driven rod, give the resistance value.

$$R = \rho / (2\pi l) * (\ln(8l/d) - 1)$$

Where ρ - resistivity
l – length
d – diameter

153. define screening coefficient.

Screening coefficient for 'n' electrodes in parallel is

= (resistance of one
electrode)/(resistance of n
electrodes in parallel * n)

substation

161. what is a substation.

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.

162. mention any two layouts of laying out a substation.

location should be at the center of the loa
should provide safe and reliable arrangement .

163. how substations are classified .

-according to 1. service requirement
constructional feature.

164. state the various types of substation according to its service requirements.

-transformer substation
-switching substation
-power factor correction substation
-frequency changer substation
-converting substation
-industrial substation

165.list the types of substations classified according to its construction.

-indoor substation

-outdoor substation

pole mounted substation

166.mention any two comparisons between indoor and outdoor substations.

INDOOR:

-space required and clearances between the conductors are less.

-time required for erection and possibility of faults are more.

OUTDOOR:

-space required and clearances between conductors are more.

-time required for erection and possibility of faults are less.

167.list the various substation equipments.

Transformer , busbars , insulators , isolators , circuit breaker , relays ,
lightening arresters.

168.define step potential.

It is the voltage between the feet of a person standing on the floor of the substation with 0.5m spacing between two feet during the flow of earth fault current through the earthing system.

169.define touch potential.

It is the voltage between the fingers of raised hand touching the faulted structure and the feet of the person standing on the substation floor. the person should not get shocked even if the earth structure is carrying faulted current .i.e touch potential should be very very low.