Subject Name:PS-II

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Year and Sem, Department: III-EEE SEM-I

Unit-I: Transmission Line Parameters

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

- The **transmission line** has mainly four **parameters**, resistance, inductance, capacitance and shunt conductance. These **parameters** are uniformly distributed along the **line**. Hence, it is also called the distributed **parameter** of the **transmission line**. ... Shunt conductance – Air act as a dielectric medium between the conductors.

Method of GMD

- Concept of Self-GMD and Mutual-GMD The use of self geometrical mean distance and mutual geometrical mean distance (mutual-GMD) simplifies the inductance calculations, particularly relating to multi conductor arrangements. The symbols used for these are respectively Ds and Dm.
- Self-GMD (DS) :
- In order to have concept of self-GMD (also sometimes called Geometrical mean radius ; GMR), consider the expression for inductance per conductor per metre
  - $= 2 \times 10^{-7} \left(\frac{1}{4} + \log_e \frac{d}{r}\right)$
  - $= 2 \times 10^{-7} \times \frac{1}{4} + 2 \times 10^{-7} \log_e \frac{d}{r}$

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Transmission lines and cables

Capacitance

$$C_{AN} = \frac{Q_A}{V_{AN}} = \frac{2\pi\,\varepsilon_0}{\ln\left(\frac{\text{GMD}}{r_c}\right)}$$

$\text{GMD} = \sqrt[3]{D_{AB}\, D_{BC}\, D_{AC}}$

Two-conductor bundle $r_{equ} = \sqrt{d\, r_c}$

Three-conductor bundle $r_{equ} = \sqrt[3]{d^2\, r_c}$

Four-conductor bundle: $r_{equ} = 1.09 \sqrt[4]{d^3\, r_c}$

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Inductance with Bundling

If the line is bundled with a geometric mean radius, R_b, then

$$\lambda_a = \frac{\mu_0}{2\pi} I_a \ln \frac{D_m}{R_b}$$

$$L_a = \frac{\mu_0}{2\pi} \ln \frac{D_m}{R_b} = 2\times10^{-7} \ln \frac{D_m}{R_b} \text{ H/m}$$

- The geometric mean radius (GMR) of two-conductor bundle is given by

where D s is the GMR of conductor

$$D_{s,2b} = \sqrt[4]{(D_s \times d)^2} = \sqrt{D_s \times d}$$

- The GMR for three-conductor and four-conductor bundles are given respectively by

$$D_{s,3b} = \sqrt[9]{(D_s \times d \times d)^3} = \sqrt[3]{D_s \times d^2}$$

$$D_{s,4b} = \sqrt[16]{(D_s \times d \times d \times \sqrt{2}d)^4} = 1.09\sqrt[4]{D_s \times d^3}$$

(i) Single phase line

Inductance/conductor/m $= 2 \times 10^{-7} \log_e \frac{D_m}{D_s}$

where $D_s = 0{\cdot}7788\, r$ and D_m = Spacing between conductors = d

(ii) Single circuit 3-ϕ line

Inductance/phase/m $= 2 \times 10^{-7} \log_e \frac{D_m}{D_s}$

where $D_s = 0{\cdot}7788\, r$ and $D_m = (d_1\, d_2\, d_3)^{1/3}$

(iii) Double circuit 3-ϕ line

Inductance/phase/m $= 2 \times 10^{-7} \log_e \frac{D_m}{D_s}$

where $D_s = (D_{s1}\, D_{s2}\, D_{s3})^{1/3}$ and $D_m = (D_{AB} \times D_{BC} \times D_{CA})^{1/3}$

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1.List out the advantages of double circuit lines over single line circuits.

2. Define - Self GMD (GMR) and mutual – G.M.D.

3.What is meant by inductive interference?

4.State the factors which govern the capacitance of a transmission line?

5. Write short note on bundle conductors.

6. Calculate the inductance of a single phase circuit comprising of two parallel conductors of 6mm in diameter spaced 1 meter apart. If the material of the conductor is copper?

7. What is transposition of conductors?

8. State why transposition of line conductors are needed?

9. List the advantages of bundled conductors.

10. Distinguish between A.C and D.C resistance of a conductor.

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1.Derive the expression for capacitance of three phase line with symmetrical spacing.

2.The three conductors of a 3-phase line are arranged in a horizontal plane with a spacing of 4 m between adjacent conductors. The diameter of each conductor is 2.5 cm. Determine the inductance per km per phase of the line assuming that the lines are transposed

3.Find inductance per phase per km length of the system of conductors shown in Figure 1. Self GMD of one conductor is 0.90 cm. Assume transposition.

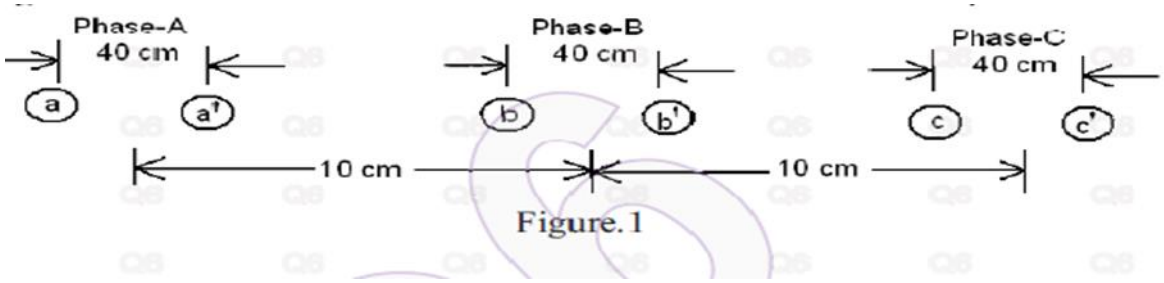

Figure. 1

4.The three conductors of a 3-phase line are arranged in a horizontal plane with a spacing of 4 m between adjacent conductors. The diameter of each conductor is 2.5 cm. Determine the inductance per km per phase of the line assuming that the lines are transposed

5.Discuss the concept of geometric mean distance. How this concept used to find the inductance of composite conductors line

8.A 3- phase transposed line has conductors of diameter 1.5cm and spaced at distance of 4, 6, 7 meters between the centers. Calculate the inductance per phase per Km of line length

6.Deduce an expression for line to neutral capacitance for a 3-phase over head transmission line when the conductors are

(a) symmetrically placed

7.A 3-phase , 50hz, 66kv over head transmission line has conductors arranged at the corners of an equivalent triangular of 3m sides and the diameter of each conductor is 1.5cm determine 'L' and 'C' per phase, if l=100km. also calculate charging current.

8.Calculate L of a single phase two wire system if D=2m and r=1.2cm?

9.A 3-phase transmission line100km long diameter =0.5cm spaced at the corner of an equivalent triangular of 120cm sides find inductance km/ph. Derive the formula used

10. .Deduce an expression for line to neutral capacitance for a 3-phase over head transmission line when the conductors are

(a) unsymmetrical placed but transposed.

Choose the Best: (Minimum 10 to 15 with Answers)

1. In order to increase the limit of distance of transmission line

(A) series resistances are used

(B) synchronous condensers are used

(C) shunt capacitors and series reactors are used

(D) series capacitors and shunt reactors are used.

Answer D

2. A 30 km transmission line carrying power at 33 kV is known as

(A) short transmission line

(B) long transmission line

(C) high power line

(D) ultra high voltage line.

Answer A

3. If K is the volume of conductor material required for 2 wire dc system with one conductor earthed, then the volume of cable conductor material required for transmission of same power in single phase 3 wire system is (A) K/3 cos φ

(B) $5K \cos^2\varphi$

(C) $K/ 5 \cos^2\varphi$

(D) $5K/ 8 \cos^2\varphi$

Answer C

4. The permissible voltage variable in voltage in distribution is

(A) 0.1%

(B) 1%

(C) 10%

(D) 50%.

Answer C

5.

6. 750 kV is termed as

(A) Medium high voltage

(B) High voltage

(C) Extra high voltage

(D) Ultra high voltage.

Answer D

7. In case of transmission line conductors with the increase in atmospheric temperature

(A) length increase but stress decreases

(B) length increases and stress also increases

(C) length decreases but stress increases

(D) both length as well as stress decreases.

Answer A

8. If the height of transmission towers is increased, which of the following parameters is likely to change ?

(A) Resistance

(B) Inductance

(C) Capacitance

(D) None of the above.

AnswerC

9. Which of the following is not the transmission voltage in America ?

(A) 66 kV

(B) l32kV

(C) 264 kV

(D) 400 kV

AnswerC

10. Which of the following is usually not the generating voltage ?

(A) 6.6 kV

(B) 9.9 kV

(C) 11kV

(D) 13.2 kV.

AnswerB

Fill in the Blanks: (Minimum 10 to 15 with Answers)

11. Boosters are basically **transformers**

12. Which of the following is not the distribution system normally used **Single phase -4 wire**

13. Conductors for high voltage transmission lines are suspended from towers **to increase clearance from ground**

14. Shunt capacitance is usually neglected in the analysis of **Short transmission lines**

15. When two conductors each of radius r are at a distance D, the capacitance between the two is proportional to **$1/\log_e (D/r)$**

16. The function of steel wire in a ACSR conductor is **to provide additional mechanical strength**

17. In high voltage transmission lines the top most conductor is **Earth conductor**

18. In aluminiumconductors steel reinforced, the insulation between aluminium and steel conductors is **no insulation is required**.

19. Under no load conditions the current in a transmission line is due to **capacitance of the line**

20. The inductance of a power transmission line increases with **Increasing in spacing between the phase conductors.**

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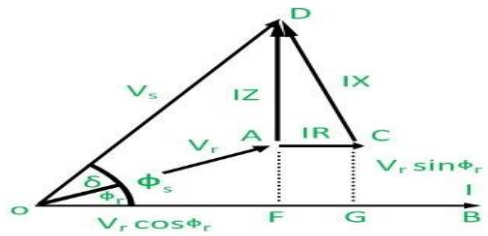
Unit-II: **Performance of Short ,Medium and Long Transmission Line**

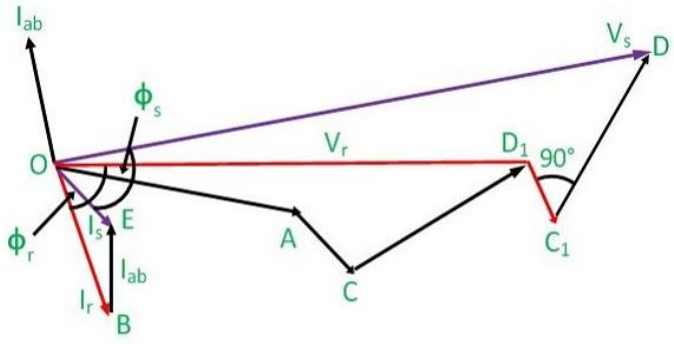
Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

Short Transmission Line

$$A = 1,\ B = Z,\ C = 0,\ D = 1$$



Phasor Diagram



Phasor diagram of a nominal T network

Circuit Globe

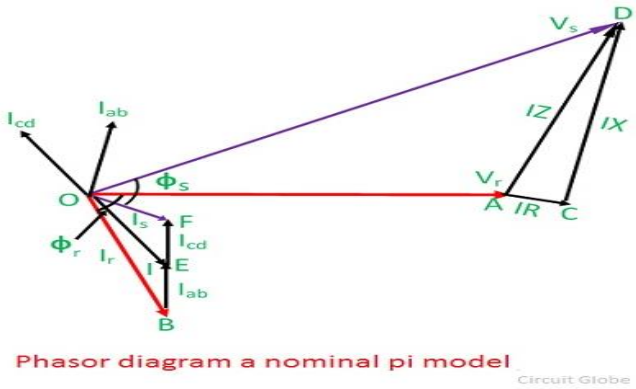
Nominal T model of a transmission line

$$A = D = 1 + \frac{ZY}{2}$$

$$B = Z\left(1 + \frac{ZY}{4}\right)$$

$$C = Y$$

Nominal Pi Model of a Medium Transmission Line

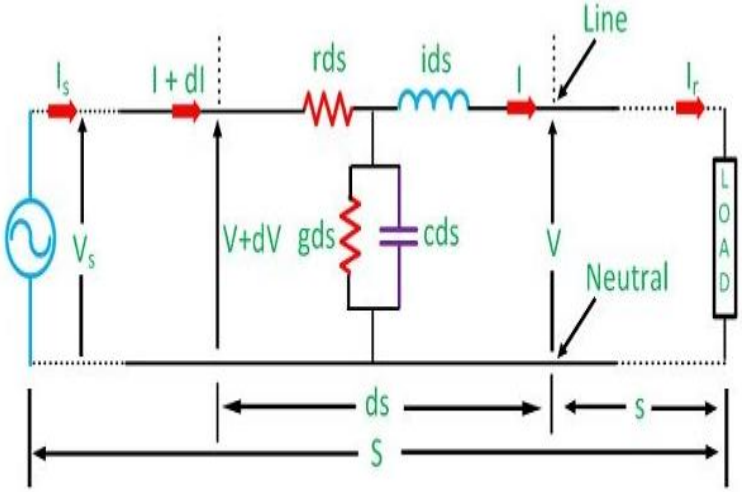


Phasor diagram a nominal pi model

Circuit Globe

$$A = D = 1 + \frac{ZY}{2};\ B = Z\ C = Y\left(1 + \frac{ZY}{4}\right)$$

Long Transmission Line



Incremental length of the transmission lines.

Circuit Globe

$$A = \cosh\gamma S$$

$$B = z_0 \sinh\gamma S$$

$$C = \frac{1}{z_o}\sinh\gamma S$$

$$D = \cosh\gamma S$$

The transmission line generates capacitive reactive volt-amperes in its shunt capacitance and absorbing reactive volt-amperes in its series inductance.The load at which the inductive and capacitive reactive volt-amperes are equal and opposite, such load is called **surge impedance load.**

$$(SIL)_{3\emptyset} = \frac{(kV_L)^2}{Z_O}\ \text{MW}$$

Ferranti Effect

Definition: The effect in which the voltage at the receiving end of the transmission line is more than the sending voltage is known as the Ferranti effect. Such type of effect mainly occurs because of light load or open circuit at the receiving end.

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1. Classify overhead transmission lines.
2. Define transmission efficiency.
3 List out the common methods of representation of medium transmission lines.
4 What is the significance of surge impedance loading?
5 What is the effect of power factor on regulation of a transmission line?
6 Give nominal – T representation of a medium line
7 Define regulation of power transmission line.
8 What is tuned power line?
9 What is surge impedance loading or natural loading?
10 Give nominal – π representation of a medium line?

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1.Obtain the equivalent π- model of medium transmission line.
2.Define regulation of a short 3 – phase transmission system and develop an expression for approximate voltage regulation?
3.Define A, B,C and D constants of a transmission line? What are their values in short lines?
4.A medium length power transmission line is represented as a nominal pi equivalent circuit with lumped parameters. The total series impedance of the line is Z and the total shunt capacitance is Y = jwC Siemens. Derive equations for the sending end voltage and current and there from determine the ABCD constants of the line. Prove that AD-BC = 1
5. Discuss the effect of load power factors on voltage regulation and efficiency of a transmission line
6.Starting from first principles show that surges behave as traveling waves. Find expressions for surge impedance and wave velocity
7.A step wave of 110 kV travels through a line having a surge impedance of 350 .The lines is terminated by an inductance of 5000 μH. Find the voltage Across the inductance and reflected voltage wave.
8. Discuss the wave length and velocity of propagation.
9.Derive the equivalent ABCD constant of a transmission line connected in series with an impedance at both ends
10.Find ABCD parameters of a three phase , 80Km, 50 Hz transmission line with series impedance (0.15=j 0.28)ohms per Km and a shunt admittance of j5*⟦10⟧^(-4) ohms per Km
Determine the series and shunt parameters for the equivalent pie and equivalent T circuit for the 50Km long line having per unit impedance and admittance as (0.2=j0.56)Ω/Km and j3.6*⟦10⟧^(-6)mho/Km respectively?

Choose the Best: (Minimum 10 to 15 with Answers)

1. Surge impedance of transmission line is given by
(A) (L/C)1/2
(B) (C/L)1/2

(C) (CL)1/2
(D) 1/(CL)1/2
Answer A
2. ACSR conductor implies
(A) All conductors surface treated and realigned
(B) Aluminum conductor steel reinforced
(C) Anode current sinusoidallyrun
(D) Anodized Core Smooth Run.
Answer B
3. The surge resistance of transmission lines is about
(A) 50 ohms
(B) 100 ohms
(C) 250 ohms
(D) 500 ohms.
Answer D
4. In transmission system a feeder feeds power to
(A) service mains
(B) generating stations
(C) distributors
(D) all of the above.
Answer C
5. For transmission lines the standing wave ratio is the ratio of
(A) maximum voltage to minimum voltage
(B) maximum current to minimum voltage
(C) peak voltage to rms voltage
(D) maximum reactance to minimum reactance.
Answer A
6. In a transmission line following arc the distributed constants
(A) resistance and inductance only
(B) resistance, inductance and capacitance
(C) resistance, inductance, capacitance and short conductance.
Answer C
7. The characteristic impedance of a transmission line depends upon
(A) shape of the conductor
(B) surface treatment of the conductors
(C) conductivity of the material
(D) geometrical configuration. of the conductors.
Answer D
8. The characteristic impedance of a transmission line depends upon
(A) shape of the conductor
(B) surface treatment of the conductors
(C) conductivity of the material
(D) geometrical configuration. of the conductors.
Answer D
9. For a distortion-less transmission line (G = shunt conductance between two wires)
(A) R/L = G/C
(B) RL=GC
(C) RG=LC

(D)RLGC=0
Answer
10. In a transmission line having negligible resistance the surge impedance is
(A) (L+C)1/2
(B) (C/L)1/2
(C) (1/LC)1/2
(D) (L/C)1/2
Answer D

Fill in the Blanks:

1. A relay used on short transmission lines is **Reactance relay**

2.In order to increase the limit of distance of transmission **are used line series capacitors and shunt reactors**

3.A 30 km transmission line carrying power at 33 kV is known as **short transmission line**

4.Surge impedance of transmission line is given by **L/C)1/2**

5.750 kV is termed as **Ultra high voltage**.

6. The ratio of capacitance from line to line capacitance from line to neutral is nearly ¼

7. The capacitance effect can be neglected in which among the transmission lines **Short transmission lines**

8. In the nominal p method which among these are divided into two halves **Shunt capacitance**

9. **Z** is the value of B parameter in case of nominal p method

10.The ABCD constants of a 3 phase transposed transmission line with linear and passive elements **Only A and D are equal**.

Unit-III: Power System Transients and Various factors affecting the transmission line

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

- **Corona** Discharge (also known as the **Corona** Effect) is an electrical discharge caused by the ionization of a fluid such as air surrounding a conductor that is electrically charged.

... **Corona** discharge can cause an audible hissing or cracking noise as it ionizes the air around the conductors.

- negative **corona**, the ions are attracted inward and the electrons are repelled outwards. The glow of the **corona** is caused by electrons recombining with positive ions to form neutral atoms.

Advantages of **Corona effect**:

- (i) 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. (ii) **Corona reduces** the **effects** of transients produced by surges.
- **Power loss in corona**

$$P_C = \frac{244}{\delta}(f + 25)(E_n - E_O)^2 \frac{\sqrt{r}}{\sqrt{D}} 10^{-5}\, kW/km/phase$$

- The **corona effects** can be **reduced** by the following methods : (i) By increasing conductor size. ... By increasing the spacing between conductors, the voltage at which **corona** occurs is raised and hence **corona effects** can be eliminated.
- **Ferranti Effect** occurs when current drawn by the distributed capacitance of the line **is** greater than the current associated with the load at the receiving end of the line which occur during light or no load. ... Shut Reactor compensation at the receiving end **might** help to **reduce** the **effect** of **Ferranti Effect**
- **Ferranti effect occurs** when **no load** or light **load** conditions,under this conditions receiving end voltage grater then sending end Voltage Resources and Information. ... When th **load** currents go very low the voltage at the **load** end of the line increases. This **effect** is called **Ferranti effect**
- **Skin effect** is a tendency for alternating current (AC) to flow mostly near the outer surface of an electrical conductor, such as metal wire.The **effect** becomes more and more apparent as the frequency increases. ... The **effect** is most pronounced in radio-frequency (RF) systems, especially antennas and **transmission lines**.
- Definition: **Proximity Effect** is the phenomena of non-uniform current distribution on the surface of adjacent current carrying conductor due to the **effect** of another current carrying conductor in its **proximity**. Since in cables, the conductors are very near to each other, this **effect** is dominant

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1 What is Ferranti effect? What is the cause of Ferranti effect?
2Define corona phenomenon? What is local corona?
3 Define critical disruptive voltage. Write the expression for it?
4Write a short note on shunt compensation?
5Write short notes on power system transients.
6Mention the advantages of Bewley's lattice
7What is skin effect?. Explain?
8What is proximity effect. Explain?
9 What are the methods adopted to reduce corona?
10Draw diagrams to show voltage and current on the line before and after the wave reaches the end of a travelling wave when it reaches the end of open circuited transmission line?

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1.(a)Derive reflection and refraction coefficient of transmission line when receiving End is open circuited
(b)A surge of 120 KV travels on a line of surge impedance 450 and reaches the junction of the line with two branch lines. The surge impedance of branch lines are 400 and 40. Find the transmitted voltage and currents
2.(a)Step wave of 100 KV travels on a line having a surge impedance of 400. The line is terminated by an inductance of 4000_H. Find the voltage across the inductance and the reflected voltage wave
(b)Write short notes on Bewleys lattice diagram
3.Explain the following in terms with reference to corona?
(a) Critical disruptive voltage
(b) Visual critical voltage
(c) Power loss due to corona
4An overload transmission line operates at 210 kV between phases at 50 Hz. The conductors are arranged in a 3.5 meter delta formation. What is the Maximum diameter of conductor that can be used for no corona loss under Fair weather conditions? Assume an air density factor of 0.9 and irregularity Factor of 0.82. The critical voltage is 230 kV. Find also the power loss under Storm conditions
5Describe the various methods for reducing corona effect in an overhead transmission line
6.Describe the various methods for reducing corona effect in an overhead transmission line
7.Explain the following terms .
i).skin effect ii).Proximity effect. Iii). Ferranti effect.
8.Draw diagrams to show voltage and current on the line before and after the wave reaches the end of a travelling wave when it reaches the end of short circuited transmission line?
9Deduce the expression for surge impedance and velocity of propagation?
(A)Two single transmission lines A and B with earth return of surge impedance510 ohm and 590 ohms respectively are connected in series and at the junction there is a resistance of 1999 ohms connected between the line and earth. If a rectangular surge wave having amplitude of 110Kv travel along A towards the junction, determine the magnitude of the voltage and the current waves at the junction point. If the transmitted wave magnitude is to be 110Kv, what should be the value of resistance R connected between the line and earth?
10.Derive reflection and refraction coefficients of transmission line when receiving end is short circuited

Choose the Best:: (Minimum 10 to 15 with Answers)

1. The relation between traveling voltage wave and current wave is
(A) e = i (L/C) 1/2
(B) e = i (C/L) 1/2
(C) e = i (iL/C) 1/2
(D) (L/iC) ½
Ans : A
2. Steepness of the traveling waves is attenuated by
(A) resistance of the line

(B) inductance of the line
(C) capacitance of the line
(D) all of the above.
Ans : A
3. The protection against direct lightening strokes and high voltage steep waves is provided by
(A) earthing of neutral
(B) lightening arresters
(C) ground wires
(D) lightening arresters and ground wires.
Ans : D

4. Voltages under Extra High Voltage are
(A) 1 kV and above
(B) 11 kV and above
(C) 132 kV and above
(D) 330 kV and above.
Ans : D
5. In outdoor substation, the lightening arresters is placed nearer to
(A) the isolator
(B) the current transformer
(C) the power transformer
(D) the current breaker.
Ans : C
6. Stability of a system is not affected by
(A) Reactance of line
(B) Losses
(C) Reactance of generator
(D) Output torque.
Ans : B
7. A 10 MVA generator has power factor 0.866 lagging. The reactive power produced will be
(A) 10 MVA
(B) 8 MVA
(C) 5 MVA
(D) 1.34 MVA.
Ans: C
8.With same maximum voltage to earth, which ac system (with p.f. 0.8) will require more copper as compared to dc 2 wire system
(A) single phase. 2 wire (mid point earthed)
(B) single phase. 3 wire (neutral=1/2 outer)
(C) three phase three wire
(D) three phase-four wire (neutral = outer).
Answer D
9. When alternating current passes through a conductor
(A) it remains uniformly distributed throughout the section of conductor
(B) portion of conductor near the surface carries more current as compared to the core

(C) portion of conductor near the surface carries less current as compared to the core
(D) entire current passes through the core of the conductor.
Answer B
10. The fact that a conductor carries more current on the surface as compared to core, is known as
(A) skin effect
(B) corona
(C) permeability
(D) unsymmetrical fault.
Answer A

Fill in the Blanks: (Minimum 10 to 15 with Answers)

1. Skin effect depends on **size of the conductor**, **frequency of the current**, **resistivity of the conductor material**
2. The skin effect of a conductor will reduce as the **resistivity of conductor material increases.**
3. Skin effect is proportional to **(diameter of conductor)2**
4. Corona usually occurs when the electrostatic stress in the air around the conductor succeeds **30 kV (maximum value)/cm**
5.Corona effect can be detected **by hissing sound, faint luminous flow of bluish color , presence of ozone detected by odor**
6.The current drawn by the line due to corona losses is **non-sinusoidal**
7. The effect of wind pressure is more predominant **on supporting towers**
8. Guard ring transmission line reduces **earth capacitance of the lowest unit**
9.The chances of corona are maximum during **humid weather**
10. In case line to line fault occurs, the short circuit current of an alternator will .depend on its **Synchronous reactance**

Unit-IV: Over Head Line Insulators and Sag and Tension Calculations

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

- **Sag** in overhead **Transmission line** conductor refers to the difference in level between the point of support and the lowest point on the conductor. ... Therefore, in order to have safe **tension** in the conductor, they are not fully stretched rather a sufficient dip or **Sag** is provided.

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- **sag and span**. **Sag** is defined as the different in level between points of supports and the lowest point on the conductor. **Sag** calculation is classified on two conditions. When supports are at equal levels.

Factors affecting the sag

- Conductor weight – Sag of the conductor is directly proportional to its weight.
- Span – Sag is directly proportional to the square of the span length.
- Tension -The sag is inversely proportional to the tension in the conductor.
- Wind – It increases sag in the inclined direction

- **Sag Template**. Definition: The **sag template** is used for allocating the position and height of the supports correctly on the profile.The **sag template** decided the limitations of vertical and wind load. It also limits the minimum clearance angle between the **sag** and the ground for safety purpose

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1 Define sag and tension in transmission line
2 What is stringing chart? What are the uses of stringing chart?
3 List out various types of insulators used for overhead transmission lines.
4 What are the main causes for failure of insulators?
5 Explain the limitations of pin type insulators
6 Explain the reason , why the insulating disc nearer to the conductor is more stressed
7 What are the factors which govern the performance of a transmission line?
8 What is the reason for sag in transmission line?
9 What is string efficiency? What are the methods to improve string efficiency?
10 List the properties of an insulator?

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1.Each line of a three phase system is suspended by a string of 4 similar insulators. If the voltage across the second unit is 15 kv and across the third unit is 27.0KV. Calculate the voltage between conductors e and string efficiency?
2. Each of the three insulators forming a string has a self capacitance of C farad. The shunt capacitance of each insulator is 0.2C to earth and 0.1C to line. A guard ring increases the capacitance of line of metal work of the lowest insulator to 0.3C.calculate the string efficiency of the arrangement with and without guard ring .
3.Discuss the consideration which govern the selection of span and conductor Configuration of a high voltage line.

4. A transmission line has a span of 200m between level supports. The cross sectional area of the conductor is1.29 cm2 weighs 1170Kg/Km and has breaking stress of 4218Kg/cm2. Calculate the sag for a factor of safety of 5, allowing wind pressure of 122 Kg per square meter of projected area. What is the vertical sag?
5. Explain how the effect ice and wind can be included in sag calculations of Transmission lines
6.An over head transmission line at a river crossing is supported from two towers of heights of 40m and 90 at the water crossing. The horizontal distance between the towers is 500m. If the maximum allowable tension is 1650 Kg and the conductor weighs 1 kg/m. find the minimum clearance of the conductor and water at a point mid-way between the supports. Bases of the towers can be considered to be at water level
7(a). What are the factors affecting sag?
8.An overload line with stranded copper conductor is supported on two poles which 210m are apart having a difference in levels of 30 m. The conductor's diameter is 20cm and weighs 2.5kg per meter length. Calculate the sag at the lower support under the conditions if wind provides a pressure of 59.5 per square meter of the projected area and a factor of safety is 5. The maximum tensile strength of copper is 4,320 kg. Persq.cm
9.Derive the expression for string efficiency of a string of 3 insulators?
10.Derive the expression for sag and tension when the support ate at unequal heights?

Choose the Best: (Minimum 10 to 15 with Answers)

1. Transmission efficiency increases as
(A) voltage and power factor both increase
(B) voltage and power factor both decrease
(C) voltage increases but power factor decreases
(D) voltage decreases but power factor increases.
Answer A
2. In overhead transmission lines the effect of capacitance can be neglected when the length of line is less than
(A) 200 km
(B) 160 km
(C) 100 km
(D) 80 km.
Answer D
3. For constant voltage transmission the voltage drop is compensated by installing
(A) synchronous motors
(B) capacitors
(C) inductors
(D) all of the above.
Answer A
4. The disadvantage of constant voltage transmission is
(A) short circuit current of the system is increased
(B) load power factor in heavy loads
(C) large conductor area is required for same power transmission
(D) air of the above.
Answer A
5. The surge impedance for over head line is taken as

(A) 10-20 ohms
(B) 50-60 ohms
(C) 100-200 ohms
(D) 1000-2000 ohms.
Answer C
6. Pin insulators are normally used up to voltage of about
(A)100kV
(B) 66 kV
(C) 33 kV
(D) 25 kV.
Answer D
7. Strain type insulator arc used where the conductors arc
(A) dead ended
(B) at intermediate anchor towers
(C) any of the above
(D) none of the above.
Answer C
8. For 66 kV lines the number of insulator discs used are
(A) 3
(B) 5
(C) 8
(D) 12.
Answer B
9. Ten discs usually suggest that the transmission line voltage is
(A) 11 kV
(B) 33 kV
(C) 66 kV
(D) 132 kV.
Answer D
10. Between two supports, due to sag the conductor takes the form of
(A) catenary
(B) triangle
(C) ellipse
(D) semi-circle.
Answer A

Fill in the Blanks:

1. Wooden poles for supporting transmission lines are used for voltages up to **22 kV**

2. Maximum permissible span for wooden poles is **60 meters**

3. When transformers or switchgears are to be installed in a transmission line, the poles used are **H type**

4. For improving life, steel poles are galvanized. Galvanizing is the process of applying a layer of **zinc.**

5. **Disc type** of insulators are used on 132 kV transmission lines ?

6. String efficiency can be improved by using **Longer cross arm grading the insulator using a guard ring**

7. Alternating current power is transmitted at high voltage **to minimize transmission losses**
8. Stranded conductors arc used for transmitting, power at high voltages because of **ease-in handling**

9. The sag of a transmission line is least affected by **current through conductor**

10. A 66 kV system has string insulator having five discs and the earth to disc capacitance ratio of 0.10.
The string efficiency will be **67%**

11.The maximum voltage of the disc type insulators is at **Near to the conductors**

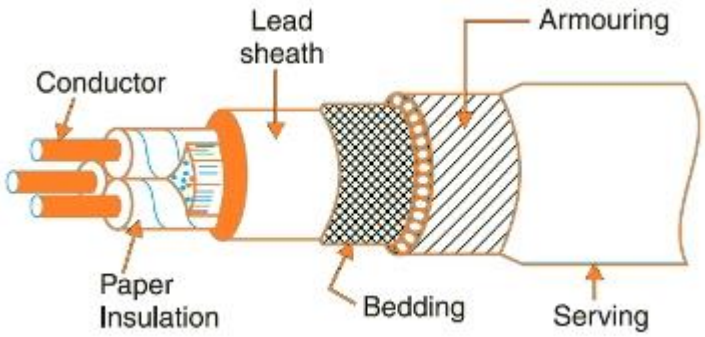
Unit-V: Under Ground cables

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

- An **underground cable** is a **cable** that is **buried** below the ground. They distribute electrical power or telecommunications. Such **cables** are an alternative to overhead **cables**, which are several meters above the ground. Overhead **cables** are often replaced with **underground cables**.

Structure of an underground cable system

- **Cable** sheath – Protects the **cable**, against moisture **in** particular. ...
- **Wire** screen – Controls the electric field and discharges fault currents. ...
- Insulating layer – Insulates the electric conductor. ...
- Electric conductor – Conducts the current.



Types of underground cables

The underground cables are classified in two ways; by the voltage capacity, or by the construction.

By Voltage

- LT cables: Low-tension cables with a maximum capacity of 1000 V
- HT Cables: High-tension cables with a maximum of 11KV
- ST cables: Super-tension cables with a rating of between 22 KV and 33 KV
- EHT cables: Extra high-tension cables with a rating of between 33 KV and 66 KV
- Extra super voltage cables: with maximum voltage ratings beyond 132 KV

By Construction

- Belted cables: Maximum voltage of 11KVA
- Screened cables: Maximum voltage of 66 KVA
- Pressure cables: Maximum voltage of more than 66KVA

Short Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1 What is grading of cables?
2What is the main purpose of bedding?
3What are the common materials used for insulation?
4What are the causes of cable break down? And also classify cables depending upon voltage?
5 What are sheath eddies in a cable?
6 What are the advantages and disadvantages of underground cable
7 What is the main purpose of armoring?
8What is serving?
9What is dielectric stress?
10Write a short note on single core cable with a neat diagram?

Long Questions (minimum 10 previous JNTUH Questions – Year to be mentioned)

1.(a) What is meant by capacitance grading of a cable
(b) Derive expressions for capacitance of and maximum potential gradient in two or more graded cable in terms of a dielectric constants and radius of core and overall radius etc.

2. Show that in a capacitance graded cable the position of different layers is decided by the product "r g Where r" is the relative permittivity of the dielectric and "g " is the dielectric strength (potential gradient) and that for a cable with overall radius R having (say) 3 dielectrics with all dielectrics working at the same maximum potential gradient "r1 r = "2 r1= "r3 r2 here r, r1, r2 are the radii of conductor, inner and middle dielectric respectively.

3.Determine the overall diameter of a single core cable and its most economical diameter when working on a 3- phase, 300kv system. The maximum permissible stress in the dielectric is not to permissible stress in the dielectric is not to exceed 20 kv\mm

4Derive the formula for dielectric stress in an underground cable.

5 Single core, lead covered cable is to be designed for 66 KV to earth. Its conductor radius is 8 mm and its three insulating materials P, Q and R have relative permittivity's of 6, 5 and 4 respectively and corresponding maximum permissible stresses of the lead sheath. 4.2, 3.8 and 3.4 kV/mm (rm) respectively. Find the minimum diameter

6 Explain carefully the constructional deference between and application of
i). deleted ii). screened (H type)
iii). S.L and iv). H.S.L types of cables.
7.Determine the overall diameter of a single core cable and its most economical diameter when working on a 3- phase, 300kv system. The maximum permissible stress in the dielectric is not to permissible stress in the dielectric is not to exceed 20 kv\mm

8.Compare underground system and over head system?

9.Derive the formula for dielectric stress in an underground cable?

10.Single core, lead covered cable is to be designed for 66 Kv to earth. Its conductor radius is 8mm and its three insulating materials P, Q and R have relative permittivity of 6, 5 and 4 respectively and corresponding maximum permissible stress of 4.2, 3.8, and 3.4Kv/mm respectively. Find the minimum diameter of the sheath.

Choose the Best: (Minimum 10 to 15 with Answers)

1. If K is the volume of cable conductor material required to transmit power, then for the transmission of the same power, the volume of cable conductor required for single phase 2 wise AC system is
(A) 2k
(B) kcosφ
(C) k/ cos2φ
(D) 2k/ cos2p
Answer D
2. The disadvantage of transmission lines as compared to cables is
(A) exposure to lightening
(B) exposure to atmospheric hazards like smoke, ice, etc.
(C) inductive interference between power and communication circuits

(D) all of the above.
Answer D
3. . Which of the following is a leading power system ?
(A) Underground cables
(B) Reactors
(C) Mercury arc rectifiers
(D)Transformers.
Answer A
4. System grounding is song
(A) so that the floating potential on the lower voltage winding for a transformer is brought down to an insignificant value
(B) so that arcing faults to earth would not set up dangerously high voltage on healthy phases
(C) so that inductive interference between power and communication circuits can be controlled
(D) for all above reasons.
Answer D
5. Transmission of power by ac cables is impossible beyond

a. 35 – 45 km
b. 500 km
c. 300 km
d. 10 – 15 km

ANSWER: A

6. What does the bedding on the cable consists of?

a. Jute strands
b. Hessian type.
c. Paper tape compounded with a fibrous material.
d. Any of these.

ANSWER:D

7. Why are sheaths used in cables?

a. Provide proper insulation.
b. Provide mechanical strength.
c. Prevent ingress of moisture.
d. None of these.

ANSWER: C

8. Why are conduit pipes employed?

a. To protect unsheathed cables.
b. Armoured cables.

c. PVC sheathed cables.
d. All of these.

ANSWER: A

9. What is the purpose of bedding on the underground cables?

a. To avoid leakage of current.
b. To protect the sheath against corrosion.
c. To protect the sheath from mechanical injury due to armouring.
d. Both (b) and (c)

ANSWER: D

10. Armouring is provided above the bedding. The armouring consists of one or two layers of which wire or tape?

a. Galvanised steel wire.
b. Thin wires of copper.
c. Wires of aluminium.
d. Wire made of both copper and cadmium.

ANSWER: A.

Fill in the Blanks:

1.Why are the inter sheaths in cables used **Provides proper stress distribution**

2.The thickness of insulation layer provided on the conductor, in cables depend **on Operating voltage**

3. **Three core** are used in a cable for the transmission of voltages upto 66 kV?

4.**Belted cables** cables are generally suited for the voltages upto 11 kV?

5.**Non magnetic and conducting** material is suitable for the manufacture of armour in a single core cable?

6.The cable best suited for the transmission of voltages from 33 kV to 66 kV is **Screened cables**

7. The charging current drawn by the cable **Leads the voltage by 90°.**

8.What does capacitance grading of cables mean **Use of dielectrics of different permittivities**

9.**3 – 5 kg / cm2** gas pressure of SF6 for a compressed gas insulated cable?

10. The ternary lead cables used near the railway track are **low specific gravity**