SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade (3rd Cycle)
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT302 – TRANSMISSION LINES AND ANTENNAS

III YEAR/ V SEMESTER

UNIT 1 – TRANSMISSION LINE THEORY

TOPIC 1 – GENERAL THEORY OF TRANSMISSION LINES

NEED FOR LINE PARAMETERS

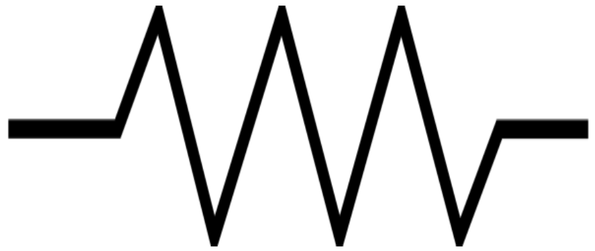
- To design a transmission line
- Understand the properties of a transmission line

TRANSMISSION LINE PARAMETERS

- Resistance (R)
- Capacitance (C)
- Inductance (L)
- Conductance (G)

RESISTANCE

- This parameter of any transmission line rely on the cross-sectional area of the conducting material
- These are distributed parameter networks that means its parameters are distributed uniformly along the entire length
- It is represented by R and its unit is ohms per unit length of the line



RESISTANCE

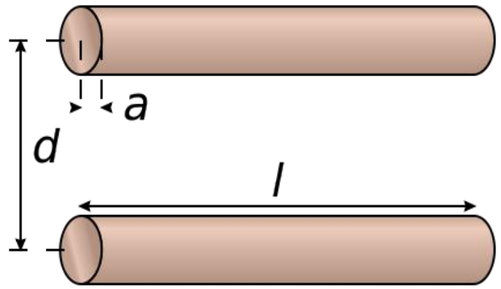
- Resistance R is given by

$$R = \rho \frac{l}{a}$$

ρ - conductivity of the conducting material
l - the length of the transmission line &
a - the cross-sectional area of the line

CAPACITANCE

- A transmission line is composed of two parallel conducting wire separated by dielectric material
- So it behaves as a parallel plate capacitor. Thus it has some capacitance which is also distributed uniformly over its length
- It is measured in farads per unit length of the transmission line



ACTIVITY

1. The secret agency Tycoon emailed some code to its agent 006. They are "RACECAR, MURDRUM, SAGAS, ATTACK, and REPAPER". Leaving one which is fake, all other words have something in common. Can you help in finding the fake word?

Answer :

The fake code-word is **ATTACK.**

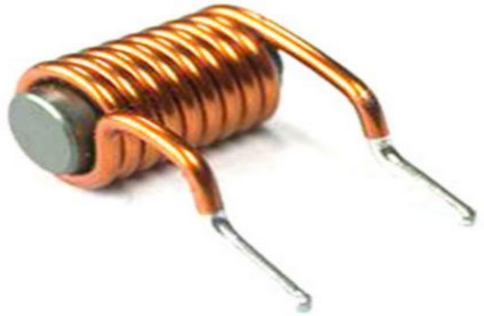
All the code-words except ATTACK are Palindromes.

INDUCTANCE

- When current flows through a conductor it generates a magnetic field perpendicular to the direction of the electric field
- As the magnetic field varies, electromagnetic flux gets generated in the line
- So, this emf now flows in opposite direction with the current flowing through the device which is known as inductance

INDUCTANCE

- Its value depends on the current flowing through the conductor
- Inductance is represented by L
- It’s unit is Henry per unit length of the conductor



CONDUCTANCE

- The two parallel conductors are separated by dielectric medium but it is not a perfect insulator
- Due to which some current also flows through the dielectric
- This current is called leakage current and it is responsible for leakage conductance through the transmission line
- It is basically present between the conducting wires and is represented by G. Its unit is mho per unit length of the conductor

RELATION TO OTHER PARAMETERS

- Transmission line Series Impedance

  $Z=R+j\omega L$

  Unit : Ohms per unit length of the line

- Transmission line Shunt admittance

  $Y=G+j\omega C$

  Unit : Mhos per unit length of the line

- Angular frequency $\omega = 2\pi f$

RELATION TO SECONDARY CONSTANTS

- Characteristic impedance $Z_0 = \sqrt{Z / Y}$

- Propagation constant $\gamma = \alpha + j\beta = \sqrt{Z Y}$

  α – attenuation constant, nepers per unit length of the line

  β – phase constant, radians per unit length of the line

- Where $Z=R+j\omega L$ & $Y=G+j\omega C$

RELATION TO SECONDARY CONSTANTS

- $\gamma Z_0 = \sqrt{ZY} \times \sqrt{Z/Y}$

  $= Z$

  $= R+j\omega L$

- $\gamma / Z_0 = \sqrt{ZY} / \sqrt{Z/Y}$

  $= Y$

  $= G+j\omega C$

SUMMARY

The four parameters of a transmission line are represented as R, L, C and G.

They used to find the properties of a transmission lines

They are also called as primary constants of a transmission line

RECTANGULAR TO POLAR FORM CONVERSIONS

➢ **EXAMPLES**

1)4+j3 (Rec) --→ 5 ∠ 36.87° (Polar)
2)10.4+j23 (Rec) --→ 25.2 ∠66° (Polar)
3)1-j (Rec) --→ 1.414 ∠-45° (Polar)
4)3+j (Rec) --→ 3.162 ∠-18.433° (Polar)

5)0.1919∠-87.66° (Polar) --→ 0.007835 – j 0.1917 (Rec)
6)63.866 ∠85.322 ° (Polar) --→ 5.208 – j 63.65 (Rec)
7)650∠-12 ° (Polar) --→ 635.8 – j 135.14 (Rec)
8)48.75∠-43.5° (Polar) --→ 35.36 – j 33.55 (Rec)

ARITHMETIC CALCULATIONS

➢ **Addition & Subtraction – Rectangular form**

EX : 1) (1+j5) + (3+j2) = 4+j7

2) (1+j5) - (3+j2) = -2+j3

➢**Multiplication & Division – Polar form**

EX :

1)360∠20° x 250 ∠-50° = 90,000 ∠-30°

2)4.482 ∠-45.44 / 35.355 ∠45 ° = 0.127 ∠-90.44°

3)√ 127.256 ∠85.31° / 288.56∠90° =0.664 ∠-2.345°

4)√127.256 ∠85.31° x 288.56∠90° =191.62 ∠87.66°

PROBLEM

- The characteristic Impedance of a uniform transmission line is 2000 ohms at a frequency of 1 KHZ. At this frequency the propagation constant was found to be 0.054 magnitude and angle 60 degrees.

- Determine the values of the line constants R,L,C & G.

SOLUTION

Solution : It is given that $Z_0 = 2000$ ohms, $\gamma = 0.054 \angle 60°$

and $\omega = 2\pi f$

$= 2 \times 3.14 \times 1000 = 6280$

$\omega = 6280$

It is known that, $R + j\omega L = \gamma \times Z_0$

$= 0.054 \angle 60° \times 2000 = 108 \angle 60°$

$= 54 + j93.53$ ohms / km

SOLUTION

Equating real and imaginary parts, we have

$$R = 54 \text{ ohms/km}$$

$$\omega L = 93.53$$

$$L = \frac{93.53}{6280} \text{ H/km}$$

$$L = 14.89 \text{ mH/km}$$

Also,
$$G + j\omega C = \frac{\gamma}{Z_0} = \frac{0.054 \angle 60^\circ}{2000} = 27 \times 10^{-6} \angle 60^\circ$$

$$= (13.5 + j23.38) \times 10^{-6} \text{ mhos / km}$$

SOLUTION

Equating real and imaginary parts,

$$G = 13.5 \times 10^{-6} \text{ mhos/km}$$

$$\omega C = 23.38 \times 10^{-6}$$

$$C = \frac{23.38 \times 10^{-6}}{6280} = 3.723 \times 10^{-9} \text{ F/km}$$

$$C = 3.723 \text{ mF/km}$$

ASSESSMENT

1.Which of the following parameters is not a primary parameter?

a) Resistance b) Attenuation constant

c) Capacitance d) Conductance

2. **The primary parameter that is associated with the magnetic flux linkage is**

a) R b) L

c) C d) G

3. **The primary parameter that is associated with the electric charges is**

a) G b) R

c) C d) L

ASSESSMENT

4. The leakage current in the transmission lines is referred to as the

a) Resistance b) Radiation

c) Conductance d) Polarisation

5. **The lines having R, L, C distributed along the circuit are called**

a) Lumped b) Distributed

c) Parallel d) Paired

REFERENCES

- J.D.Ryder “Networks, Lines and Fields”, PHI, New Delhi, 2003
- Raju, “Electromagnetic Field Theory and Transmission Lines”, Pearson Education, 2005.

THANK YOU