23|09|2024

ELEC345

Lecture 1 Conductors at RF and transmission lines

ELEC345: High Speed Communications Wired and Wireless

Dr Toby Whitley (Reynolds 114)

80% Exam

20% Coursework

i & j represents phase shift but also → complex number / $\sqrt{-1}$ imaginary number

j is a 90° phase shift

$$X_L = j\omega L$$
$$X_C = \frac{1}{j\omega C} \Rightarrow \omega = 2\pi f$$

1 - Why are transmission lines important?
- a means of transmitting energy with reduced loss over a conductor
- a way of maintaining the integrity of data and signals

Other questions to explore:

2 - When does a wire become a transmission line?

3 - What are their practical applications and limitations?

Wires at DC

$$\text{Resistance} = \frac{\text{Length}}{\text{Conductivity} \times \text{Cross-sectional area (CSA)}}$$

$$\text{" \quad "} = \frac{\text{Length} \times \text{Resistivity}}{\text{CSA}}$$

Wires at AC

AC resistance (also known as impedance) increases with frequency due to two phenomena:

1 - Skin effect

2 - Proximity effect

Commonly seen Transmission lines

a) Coax cable

b) Wire over ground

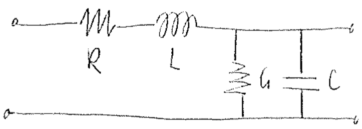
c) Tri-lead wire

d) Twisted pair

- Universal Serial Bus (USB)
- Serial advanced technology attachment (SATA)
- Peripheral component interconnect express (PCIe)
- Gigabit Ethernet

These are modern wired communication standards

Transmission line models




R : Resistance (Ω)

L : Inductance (Henrys / H)

G : Conductance (Siemens / S)

C : Capacitance (Farads / F)

Characteristic Impedance $Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$ ← Telegraphers Equation

Wave Equation

General Equation for any travelling wave: sound, light, etc.

$$\frac{\delta^2 A}{\delta x^2} - \frac{1}{V_p^2}\frac{\delta^2 A}{\delta t^2} = 0$$

Reflection Coefficient, $\Gamma = \frac{V^-}{V^+} = \frac{Z_L - Z_0}{Z_L + Z_0}$

$Z_S$ : Input Impedance

$Z_L$ : Load Impedance

$Z_0$ : Characteristic Impedance