

EECS 723-Microwave Engineering

Teacher: *"Bart, do you even know your multiplication tables?"*

Bart: *" Well, I know of them".*

Like Bart and his multiplication tables, many electrical engineers know **of** the concepts of microwave engineering.

Concepts such as characteristic impedance, scattering parameters, Smith Charts and the like are familiar, but often we find that a **complete, thorough and unambiguous** understanding of these concepts can be somewhat lacking.

Thus, the goals of this class are for **you** to:

- 1.** Obtain a complete, thorough, and unambiguous understanding of the fundamental concepts on microwave engineering.
- 2.** Apply these concepts to the **design and analysis** of useful microwave devices.

2.1 - The Lumped Element Circuit Model for Transmission Lines

Reading Assignment: pp. 1-5, 49-52

The most important fact about microwave devices is that they are connected together using transmission lines.

Q: *So just what is a transmission line?*

A: A passive, linear, two port device that allows bounded E. M. energy to flow from one device to another.

→ Sort of an "electromagnetic pipe" !



Q: *Oh, so it's simply a conducting wire, right?*

A: NO! At high frequencies, things get much more complicated!

HO: The Telegraphers Equations

HO: Time-Harmonic Solutions for Linear Circuits

Q: *So, what complex functions $I(z)$ and $V(z)$ do satisfy both telegrapher equations?*

A: The solutions to the transmission line wave equations!

HO: The Transmission Line Wave Equations

Q: *Are the solutions for $I(z)$ and $V(z)$ completely independent, or are they related in any way?*

A: The two solutions are related by the transmission line characteristic impedance.

HO: The Transmission Line Characteristic Impedance

Q: *So what is the significance of the complex constant γ ? What does it tell us?*

A: It describes the **propagation** of each **wave** along the transmission line.

HO: THE COMPLEX PROPAGATION CONSTANT

Q: *Now, you said earlier that **characteristic impedance Z_0** is a **complex** value. But I recall engineers referring to a transmission line as simply a "50 Ohm line", or a "300 Ohm line". But these are **real** values; are they **not** referring to characteristic impedance Z_0 ??*

A: These real values are in fact some **standard Z_0** values. They are **real** values because the transmission line is **lossless** (or nearly so!).

HO: THE LOSSLESS TRANSMISSION LINE