4.3 – The Scattering Matrix

Reading Assignment: ***pp. 174-183***

Admittance and Impedance matrices use the quantities $I(z)$, $V(z)$, and $Z(z)$ (or $Y(z)$).

Q: *Is there an **equivalent** matrix for transmission line activity expressed in terms of $V^+(z)$, $V^-(z)$, and $\Gamma(z)$?*

A: Yes! Its called the **scattering matrix**.

HO: THE SCATTERING MATRIX

Q: *Can we likewise determine something **physical** about our device or network by simply **looking** at its scattering matrix?*

A: HO: MATCHED, RECIPROCAL, LOSSLESS

EXAMPLE: A LOSSLESS, RECIPROCAL DEVICE

Q: *Isn't all this linear algebra a bit **academic**? I mean, it can't help us design components, **can it**?*

A: It sure can! An analysis of the scattering matrix can tell us if a certain device is **even possible** to construct, and if so, what the **form** of the device must be.

HO: THE MATCHED, LOSSLESS, RECIPROCAL 3-PORT NETWORK

HO: The Matched, Lossless, Reciprocal 4-port Network

Q: *But how are scattering parameters **useful**? How do we use them to **solve or analyze** real microwave circuit problems?*

A: Study the **examples** provided below!

Example: The Scattering Matrix

Example: Scattering Parameters

Q: *OK, but how can we **determine** the scattering matrix of a device?*

A: We must carefully apply our **transmission line theory**!

Example: Determining the Scattering Matrix

Q: *Determining the Scattering Matrix of a multi-port device would seem to be particularly laborious. Is there any way to simplify the process?*

A: Many (if not most) of the useful devices made by us humans exhibit a high degree of **symmetry**. This can greatly **simplify** circuit analysis—if we **know how** to exploit it!

HO: Circuit Symmetry

Example: Using Symmetry to Determining a Scattering Matrix

Q: *Is there any **other** way to use circuit symmetry to our advantage?*

A: Absolutely! One of the most **powerful** tools in circuit analysis is **Odd-Even Mode** analysis.

HO: SYMMETRIC CIRCUIT ANALYSIS

HO: ODD-EVEN MODE ANALYSIS

EXAMPLE: ODD-EVEN MODE CIRCUIT ANALYSIS

Q: *Aren't you **finished** with this section yet?*

A: Just **one more** very important thing.

HO: GENERALIZED SCATTERING PARAMETERS

EXAMPLE: THE SCATTERING MATRIX OF A CONNECTOR