Lec 9 - Smith Applications & 5-params

- Smith Coordinates

-> Assignment Schedule Change <-

- We're working on Smith charts

It's a way to represent load impedance and/or reflection coeff (some thing)

It's wanted this to model periodic impedance transform of t. line

Example: plot of the $\Gamma$ plane overlaid w/ Z_{ni} coordinate system

- Constant $r$ circles
- Move along these as $x$ changes

- Looked at some examples

  - $Z_L = 50 + 50\angle \theta$ at $Z_0 = 50$
    
    $\rightarrow Z_{ni} = 1 + \frac{1}{2}$
    
    $\rightarrow \Gamma = \frac{1}{2} + \frac{2}{5} \angle$ plausible

  - $Z_L = 50 + \omega L$ at $Z_0 = 50$

    - $Z_{ni} = 1 + \omega L / 50$
      
      - $\omega = 0 \rightarrow$ ind short
        no imaginary part
      
      - $\omega = \infty \rightarrow$ all range
        $\rightarrow \Gamma \rightarrow \Gamma = 1$

- $\Gamma$ coordinates would be rectangular

- Constant $\delta$ arcs
- Center $\frac{1}{2}$ top circle are infinite in other system

- Defined by intersection of 1 circle to 1 arc

- Changing $\omega$ values

  - not on arc 6/c
  
  $\omega > 0$, +imm. part
Smith charts can be used to determine what Z achieves a goal.

- Say we want \( \Gamma = 0 \) \( \Rightarrow \) max power delivery
- \( \Rightarrow \) no confusing reflections
- But, we have \( Z_{in} = 1 + j \) for our OUT
- We can add \( Z_{ser} \)

\[
\begin{align*}
Z_o &= 50 \\
\end{align*}
\]

You guys: What should \( Z_{ser} \) be? \( R, L \) or \( C \)?

Hints: do we want to add \((+ve) x\) or \((-ve) x\)?

- We want a series cap, with negative impedance

- How much?

  \[
  \text{new } Z_{in} = \frac{(Z_{ser} + Z_{out})}{50}
  \]

  \[
  = \frac{1}{50 \omega C} + 1 + j
  \]

  \[
  = \frac{1}{50 \omega C} \cdot j + j + 1 \text{ \ if } \omega \frac{1}{50 \omega C} = 1
  \]

- Necessarily a narrow band match.

- What if we want to add something in parallel?

\[
\begin{align*}
\Gamma &= \frac{Z_{in} - 1}{Z_{in} + 1} = \frac{1/Y_{in} - 1}{1/Y_{in} + 1} = -\frac{Y_{in} - 1}{Y_{in} + 1} \\
\end{align*}
\]

But

Implies a similar transform from \( Y_{in} \) to \( \Gamma \)

\( \Gamma \) same as Smith rotated by 180°.
How does this look?

\[ Y_{1L} = g + j\beta \]  

- \( g \) circles  
- \( \beta \) arcs

- For \( Z_0 = 50 \Rightarrow Y_0 = \frac{1}{50} = 0.02 \)
- Cap and inductor flipped \( \beta \)
- Admittance is opposite sign

Consider matching 100 ohm resistor to 50 ohm line

- Not on constant \( R \) arc. Can't add series element to fix

- Add shunt cap - move down admittance curve
- Add series \( L \) to move up \( R \) curve - line up with green curve that passes through origin
- Then add shunt cap
- Matched a non-50 ohm load! Wow!
- Why not parallel \( R \)

Reminder of \( z \) lines

- Plotting on \( \Gamma \) plane
- \( \Gamma(z) = \frac{\zeta}{\zeta + 1} \)
- Rotate to new phase around origin by \( 2\pi \)
- \( \frac{\lambda}{4} \Rightarrow \frac{\lambda}{2} \rightarrow 2\pi \)
- \( \frac{\lambda}{8} \) takes cap to real

S-parameter tensor:
- Power to load?