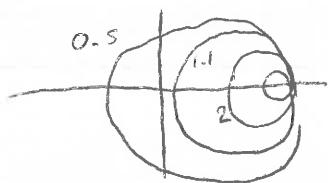


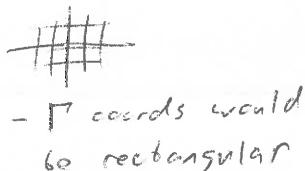
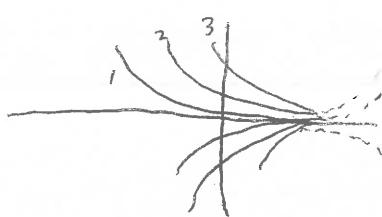
- Smith Coordinates
  - Modifying  $Z_L$  w/ stuff in series
  - Modifying  $Z_L$  w/ stuff in parallel
  - Modifying  $Z_L$  w/ T-lines

→ Assignment Schedule Change ↴

- We're working on Smith charts
  - ↳ way to represent load impedance and/or reflection coeff (some thing)
  - ↳ wanted this to model periodic impedance transform of t. line
  - ↳ plot of the  $\Gamma$  plane overlaid w/  $Z_{NL}$  coordinate system
    - $Z_{NL} = Z_L/Z_0$
    - non-rectilinear
    - but  $r \perp x$
- Last time we showed how  $Z_{NL}$  coords appear on  $\Gamma$  plane



- constant  $r$  circles
- move along these as  $x$  changes



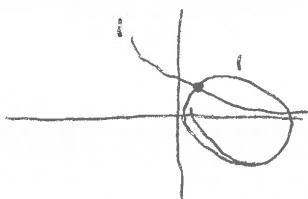
- constant  $x$  arcs
- center @  $\frac{1}{x} \rightarrow$  top edges of  $\Gamma$  diagram

- Looked @ some examples

$$\bullet Z_L = 50 + 50j \quad \& \quad Z_0 = 50$$

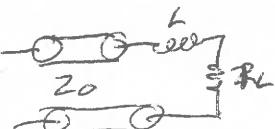
$$\hookrightarrow Z_{NL} = 1 + j$$

$$\hookrightarrow \Gamma = \frac{1}{5} + \frac{2}{5}j \quad \text{... plausible}$$



- defined by intersection of 1 circle 2 line

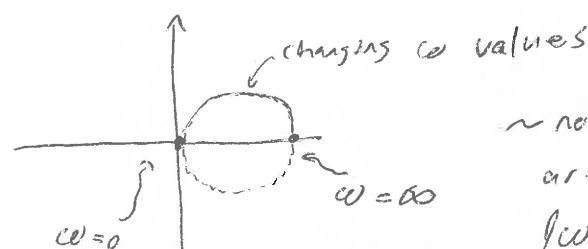
$$\bullet Z_L = 50 + j\omega L \quad \& \quad Z_0 = 50$$



$$- Z_{NL} = 1 + j\omega L / 50$$

- $\omega = 0 \rightarrow$  ind short
- no imag part

- $\omega = \infty \rightarrow$  all image
- $\rightarrow \Gamma = 1$

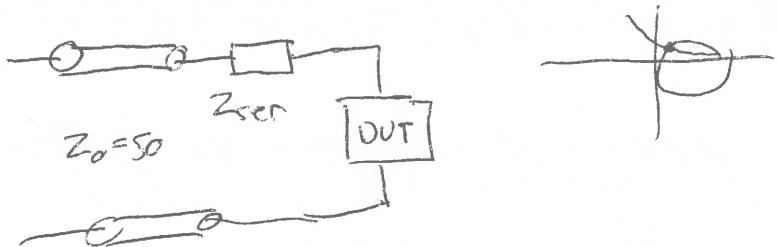


- not on -ve arc b/c  $j\omega > 0$ , + imag. part

$$\left| \frac{jx - Z_0}{jx + Z_0} \right| = \frac{\sqrt{Z_0^2 + X^2}}{\sqrt{Z_0^2 + X^2}}$$

- Smith charts can be used to determine what  $Z$  achieves a goal
  - ~ say we want  $P=0$  ~ max power delivery
    - ~~ no confusing reflections
  - ~ but we have  $Z_{in} = 1+j\frac{1}{2}$  for our DUT

- ~ we can add  $Z_{ser}$



You guys: what should  $Z_{ser}$  be? R, L or C?

↳ Hint: do we want to add (+ve)  $X$  or (-ve)  $X$ ?

- we want a series cap with negative impedance

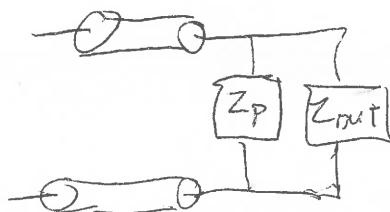
$$\text{- How much? new } Z_{in} = (Z_{ser} + Z_{out})/50$$

$$= \frac{1}{j50\omega C} + 1 + j$$

$$= \frac{-1}{50\omega C} + j + j + 1 \quad \text{want } \frac{-1}{50\omega C} = 1$$

- ~ Necessarily a narrow band match

- What if we want to add something in parallel



$$Z_L = \frac{Z_0 Z_{out}}{Z_0 + Z_{out}} \quad \text{~not amenable to simple Smith interpretation.}$$

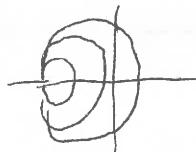
DUT

$$P = \frac{Z_{in} - 1}{Z_{in} + 1} = \frac{Y_{in} - 1}{Y_{in} + 1} = -\frac{Y_{in} - 1}{Y_{in} + 1}$$

Implies a similar transform from  $Y_{in}$  to  $P$   
+ same as Smith rotated by  $180^\circ$

- How does this look?

$$Y_{1L} = g + jB \text{ or } \text{susceptance}$$

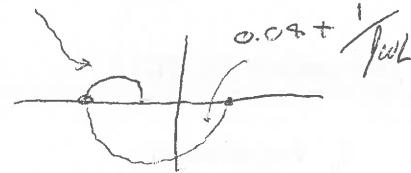


constant g circles



constant b arcs

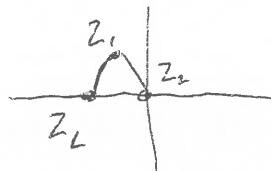
$$0.004 + j0.06$$



$$\text{for } Z_0 = 50 \rightarrow Y_0 = 1/50 = 0.02$$

- Cap and inductor flipped b/c 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 or move down admittance curve~~

- Add series L to move up r curve & line up w/ ~~g~~ curve that passes through origin

- Then add shunt cap

- Matched a non-50 ohm load! Wow!

- Why not parallel R

- Remember or t-lines

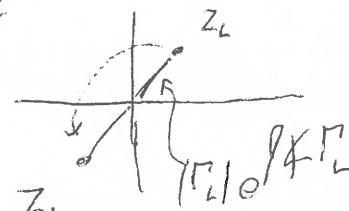
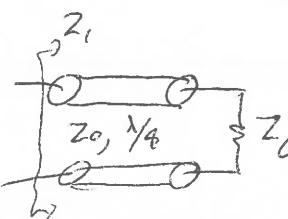
- plotting on  $\Gamma$  plane

$$-\Gamma(z) = \Gamma_L e^{2jz}$$

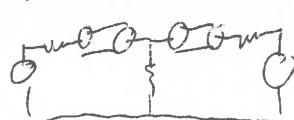
- rotate to new phase about origin by  $2jz$

$$-\frac{\lambda}{4} \rightarrow \pi, \frac{\lambda}{2} \rightarrow 2\pi$$

-  $\frac{\lambda}{4}$  takes cap to real



S-param tease:  
power to load?



$$\text{line } \Gamma_L e^{\frac{j(\lambda L + 2jz)}{2}}$$

$$= \pi \text{ for } \frac{\lambda}{4}$$