Lecture 36

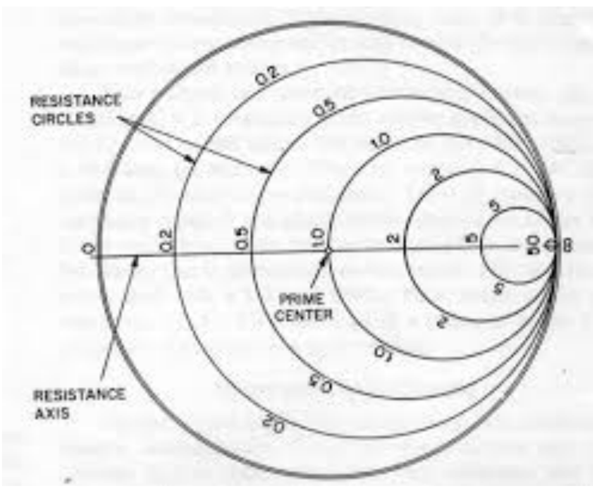
1 Smith Chart introduction

Download the Smith chart through this link. You can print it in black.

Smith chart is the complex Γ plane. The outer periphery is $\Gamma = 1$ unit circle. The origin is $\Gamma = 0$.

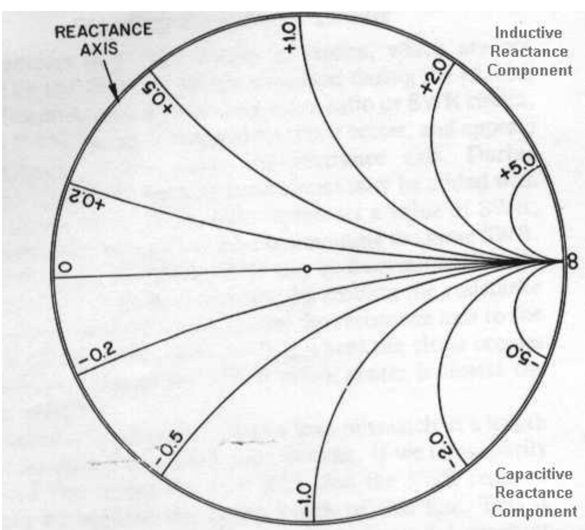
Möbius transformation above translate complex line impedance $z = r + jx$ into the smith chart of Γ values.

- For $r = const$ lines on complex z plane, they transform into smith chart as circles



- ○ $z = 0$ (short) → left side on center line
- ○ $z = 1$ (matched) → origin
- ○ $z = \infty$ (open) → right side on center line

- For $x = const$ lines on complex z plane, they also transform into smith chart as circles, but we only care about the arcs inside the $\Gamma = 1$ unit circle



○ Arcs on upper half plane → inductive reactance ($x > 0$)
○ Arcs on lower half plane → capacitive reactance ($x < 0$)

2 Examples using Smith Chart

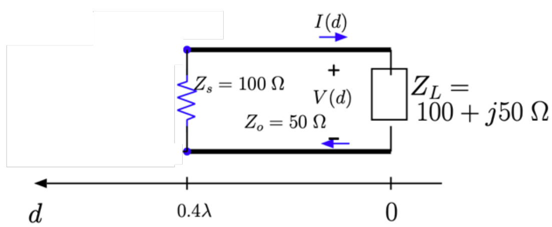
Please watch the lecture to see the following examples on how to use Smith chart!

2.1 Example – From load impedance Z_L to input impedance Z_{in}

2.2 Example – From Z to Y

3 Example 1: From load to Input impedance and admittance

A load $Z_L = 100 + j50\ \Omega$ is connected across a TL with $Z_o = 50\ \Omega$ and $l = 0.4\ \lambda$. At the generator end, $d = l$, the line is shunted by an impedance $Z_s = 100\ \Omega$. What are the input impedance Z_{in} and admittance Y_{in} of the line, including the shunt connected element.



This example shows 2 ways of using Smith Chart.

- From load impedance Z_L to input impedance Z_{in}

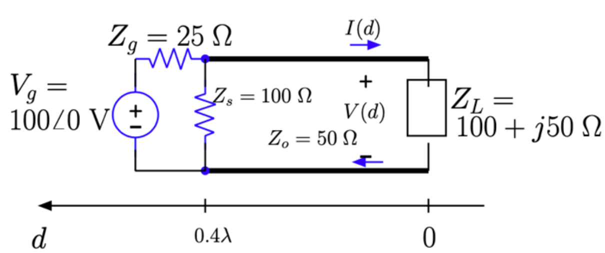
  Rotate towards generator → circle in clockwise direction

- From impedance Z to admittance Y

  Find the opposite position w.r.t. center.

1 Example 2: Average power

Example 2: The TL network described in Example 1 is connected to a generator with open circuit voltage phasor $V_g = 100\angle 0$ V and internal impedance $Z_g = 25\ \Omega$. What is the average power (a) input of the shunted line, (b) delivered to the shunt element, delivered to the load.



a) Average power P_{in} at the input of the shunted line

$$P_{in} = \frac{1}{2} Re\{VI^*\}$$

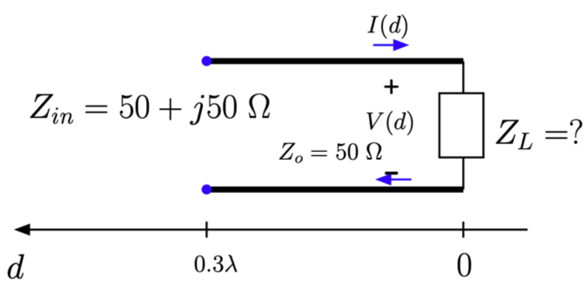
Need V_{in} by voltage division.

b) Average power P_L of the load Z_L

Because TL is lossless, average power of the input P_{in}= average power of Z_s + P_L

2 Example 3: From input to load

Example 3: A TL of length $l = 0.3\ \lambda$ has an input impedance $Z_{in} = 50 + j50\ \Omega$. Determine the load impedance $Z_L = Z(0)$ and $Y_L = Y(0)$ given that $Z_o = 50\ \Omega$ for the line.



- From input impedance Z_{in} to load impedance Z_L

  Rotate towards load → circle in counterclockwise direction