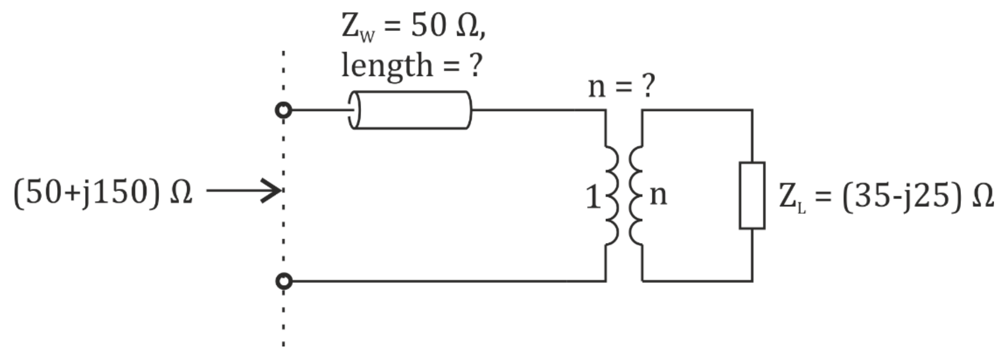
31. Impedance transformation - Reference Solution

The following circuit is to transform the load impedance ZL into the given input impedance.



Use the Smith-Chart to determine the transformer's winding ratio and the line length (in fractions of the wavelength)!

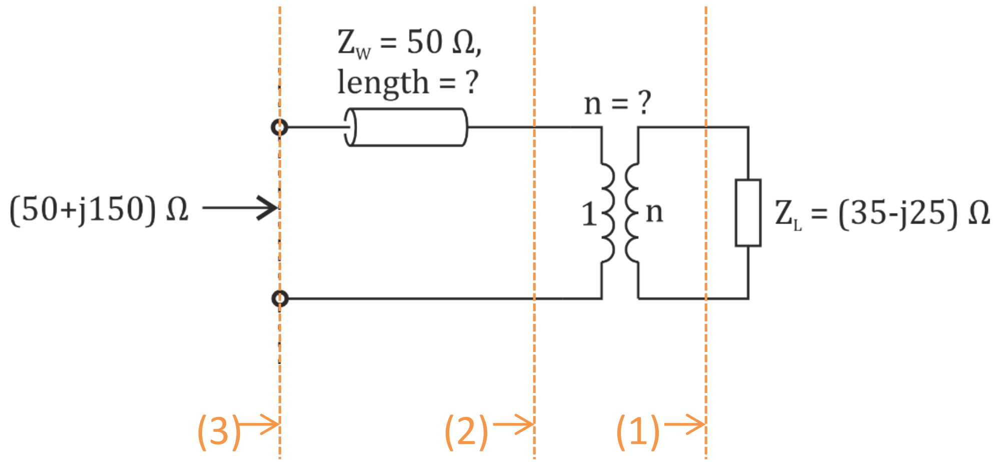
Find the solution with the shortest possible transmission line length!

RF Techniques

The following notation will be used in the Smith-charts:

- impedances are marked in **BLUE**
- admittances are marked in **RED**
- construction steps are marked in **ORANGE**
  (sometimes other colors might also be used for clarity)
- the reference impedance is indicated in to upper left corner
- pastel colors are used for preceding construction steps, impedances, and admittances

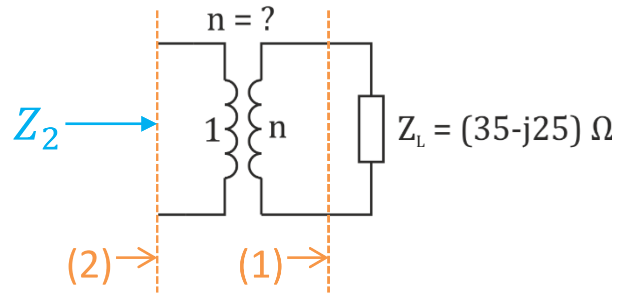
- reference planes are denoted by (1),(2),(3);
  they are located at the following positions and use the following orientations:



RF Techniques

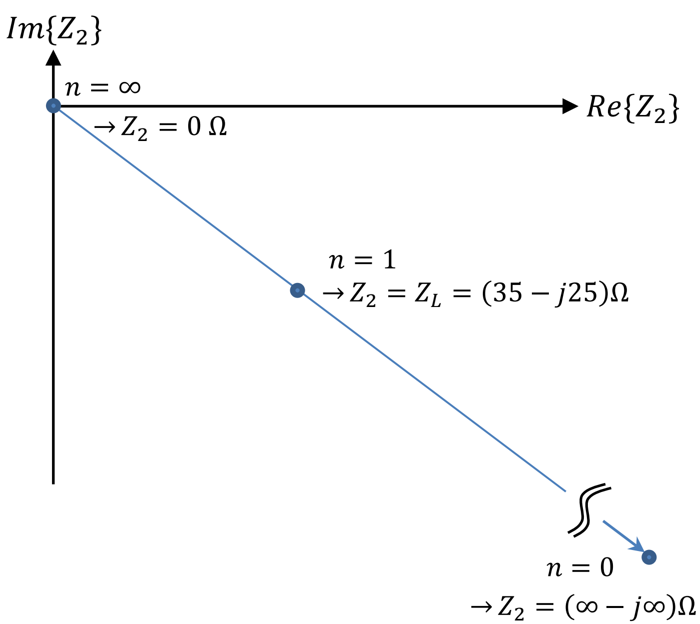
31. Impedance transformation - Reference Solution

How to handle a variable transformer in the Smith-chart?



→ The impedance Z_L is transformed to $Z_2 = \frac{1}{n^2} Z_L$.

→ The possible values of Z_2 form a straight line in the Z-plane:



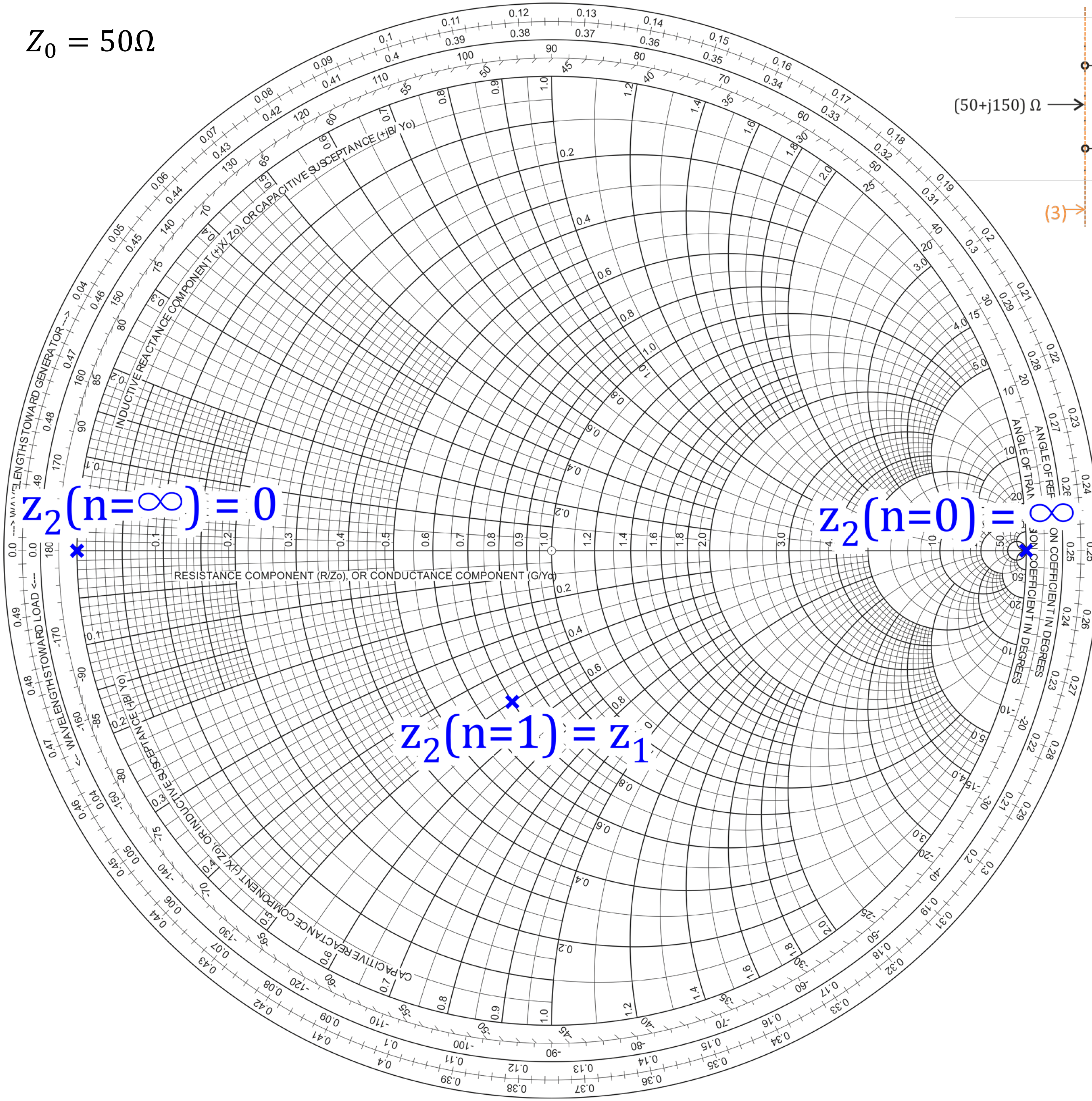
We know from other examples:
Circles or lines (which are infinite radius circles) always transform into circles!

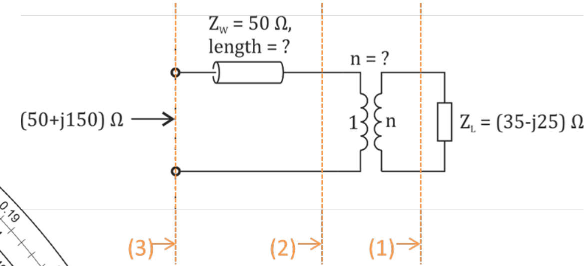
Thus, we expect an arc in the Smith-chart going through

- $z = 0$ $(\Gamma = -1)$, short-circuit
- $z = \infty - j\infty$ $(\Gamma = +1)$, open
- $z = z_L$, normalized Z_L impedance

31. Impedance transformation - Reference Solution

$Z_0 = 50\Omega$



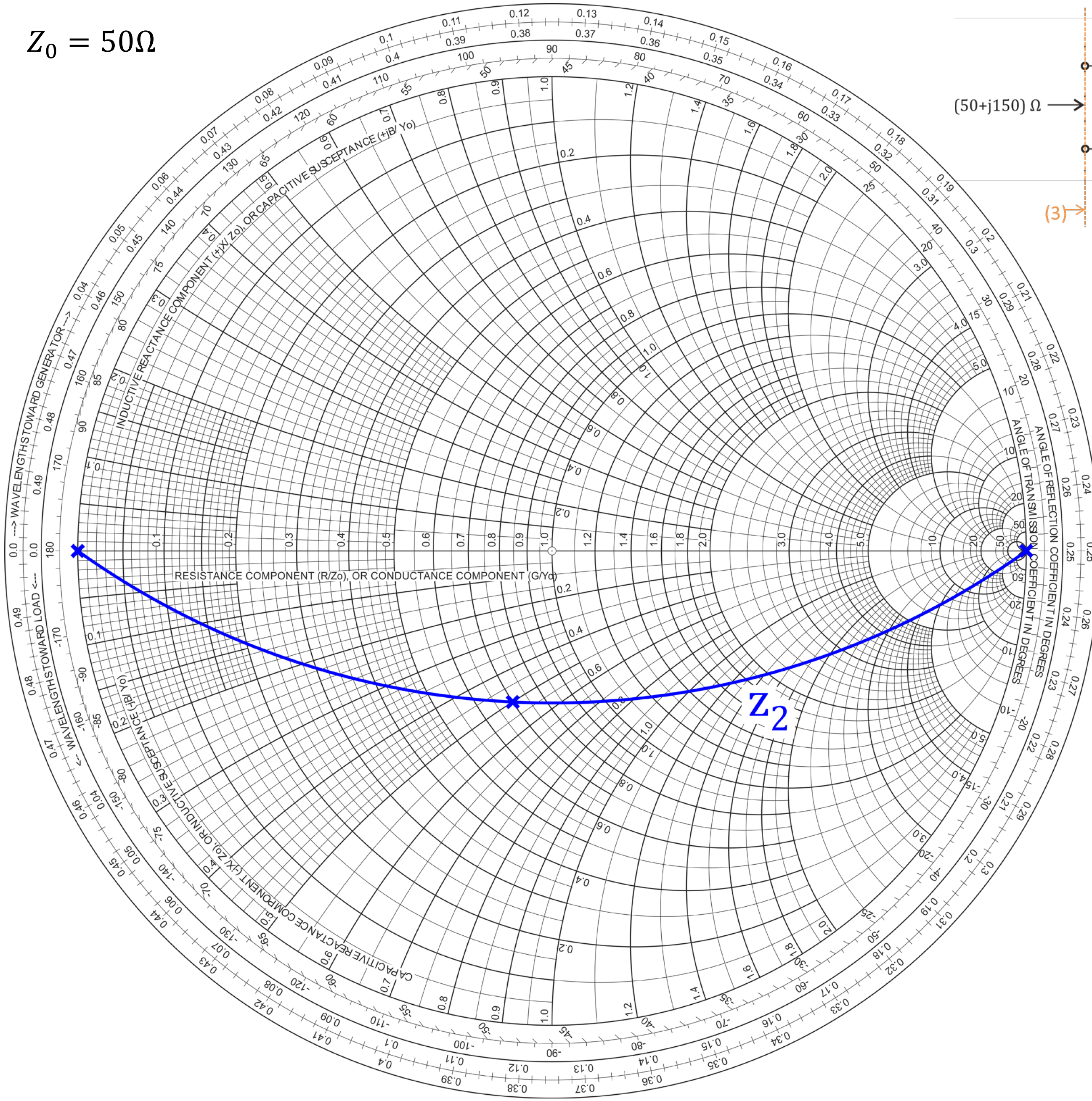


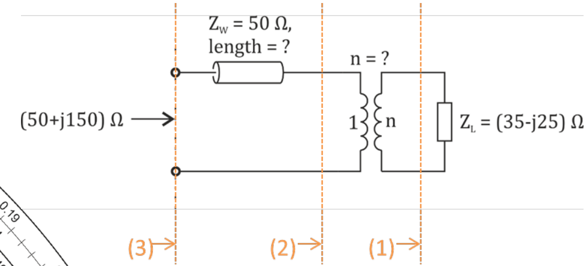
Solution:

- **Enter three different values of $z_2 = \frac{z_1}{n^2}$ (any values of n can be used)**
- **Use a 50 Ω Smith-chart (because of the line)**

31. Impedance transformation - Reference Solution

$Z_0 = 50\Omega$



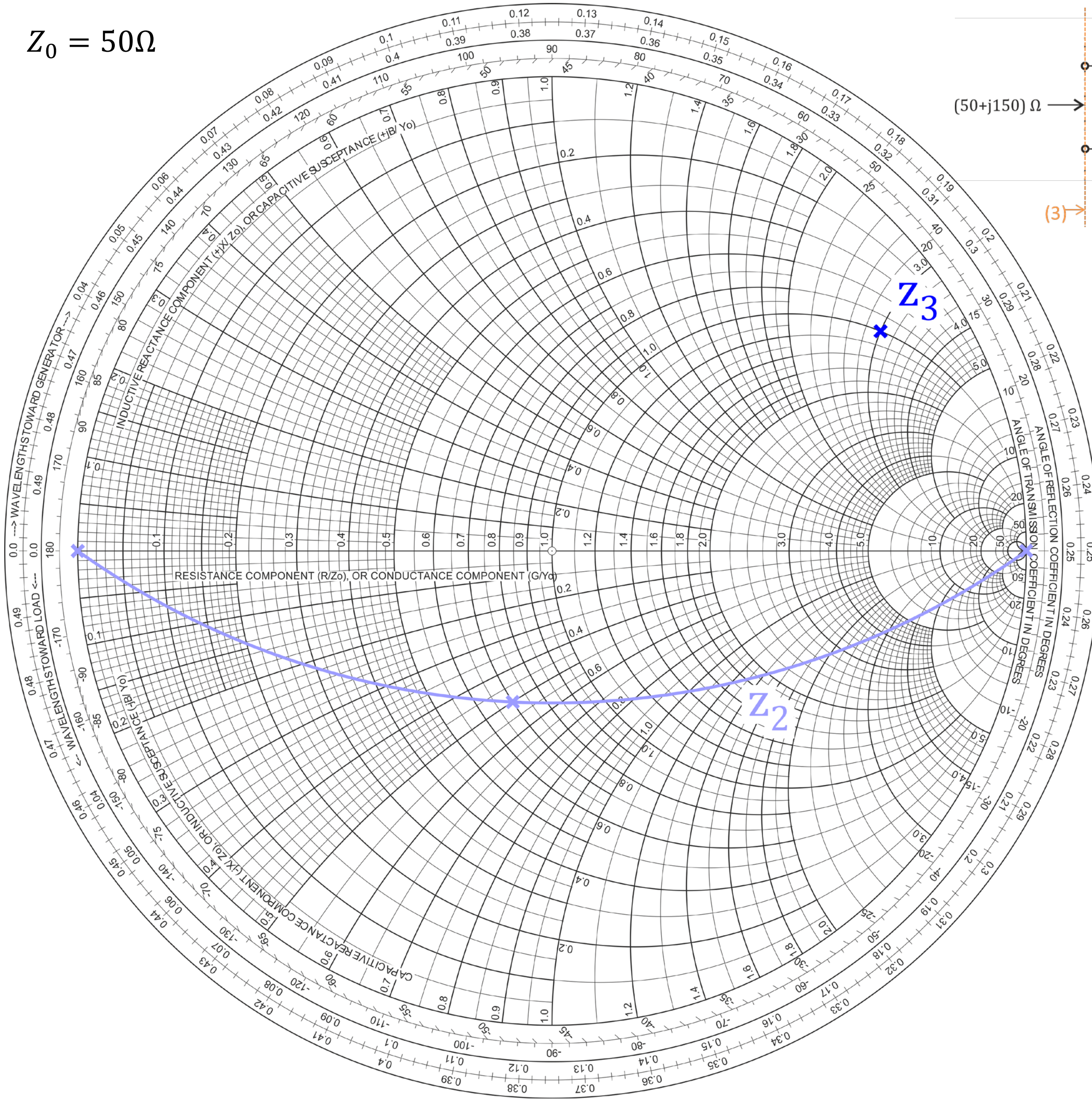


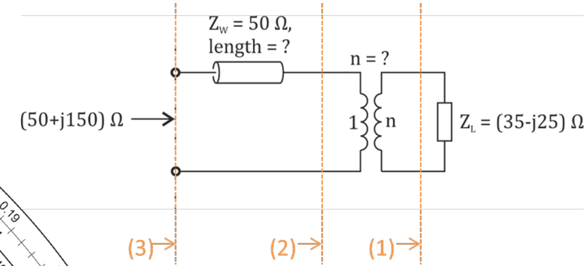
Solution:

- Enter three different values of $z_2 = \frac{z_1}{n^2}$
- **Construct an arc connecting those three points**
  This arc shows all possible values of z_2 which can be achieved.

31. Impedance transformation - Reference Solution

$Z_0 = 50\Omega$



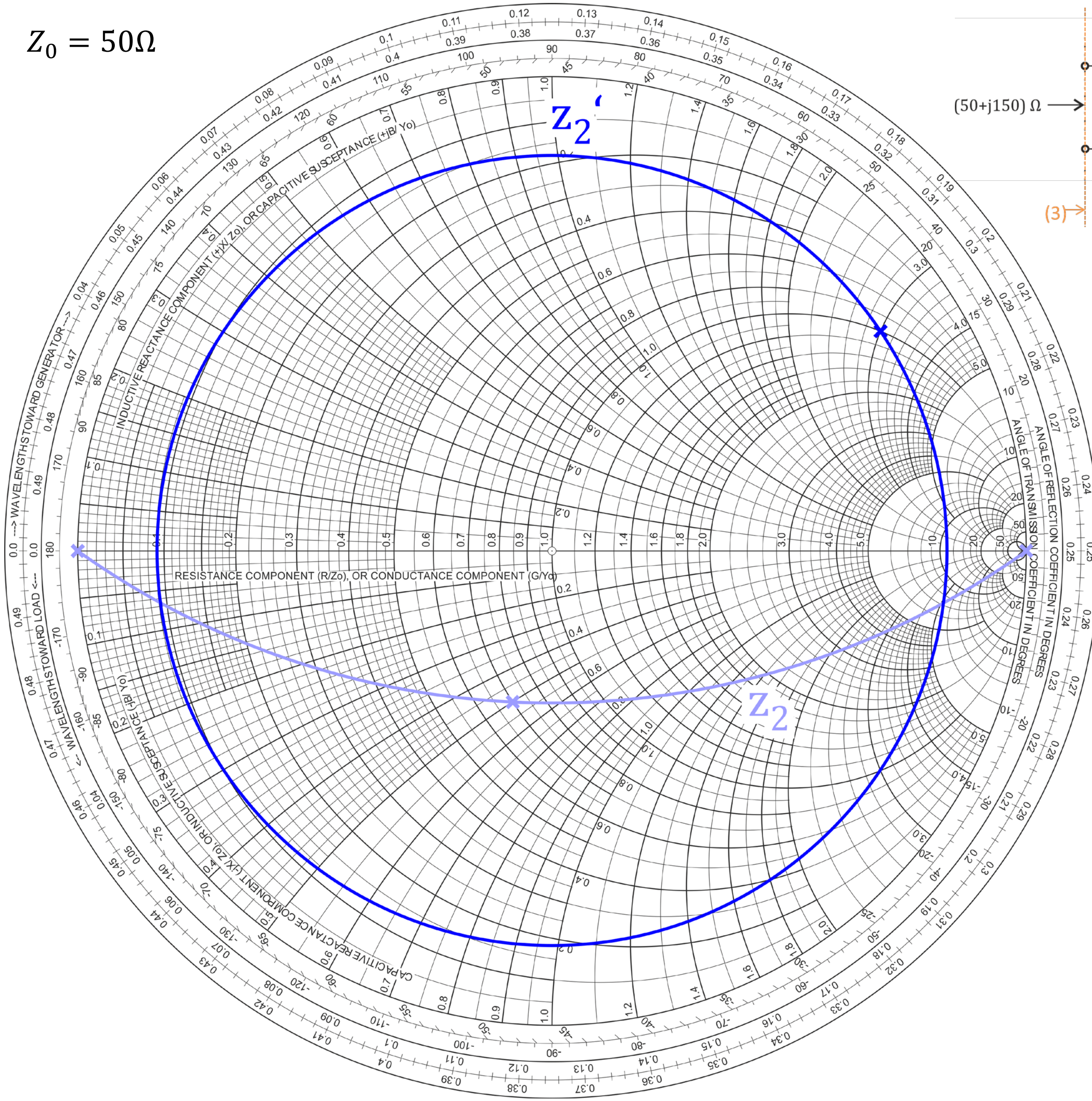


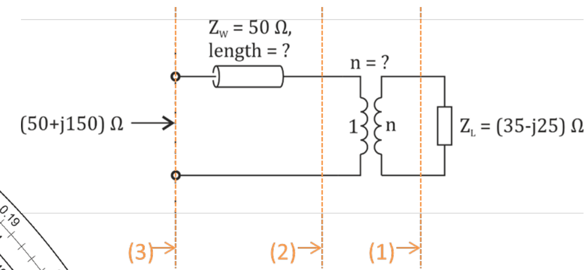
Solution:

- Enter three different values of $z_2 = \frac{z_1}{n^2}$
- Construct an arc connecting those three points
- **Enter the targeted impedance $z_3 = 1 + j3$**

31. Impedance transformation - Reference Solution

$Z_0 = 50\Omega$



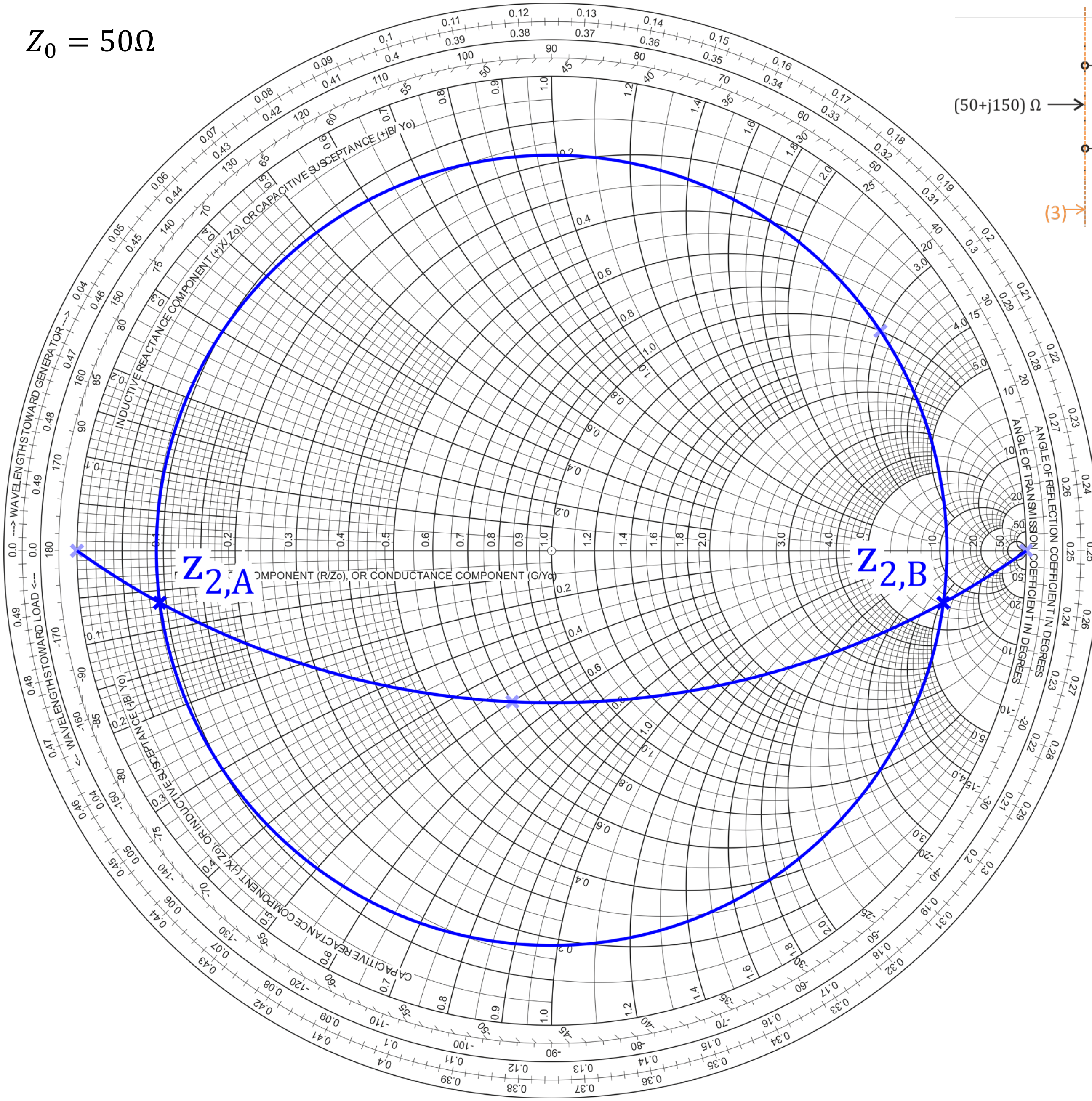


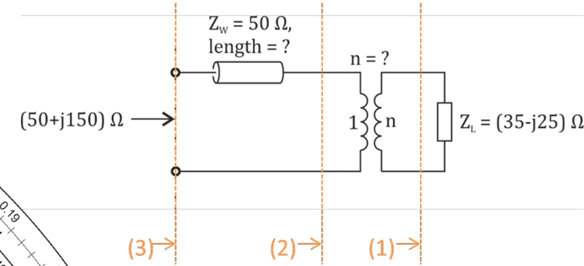
<u>Solution:</u>

- Enter three different values of $z_2 = \frac{z_1}{n^2}$
- Construct an arc connecting those three points
- Enter the targeted impedance $z_3 = 1 + j3$
- **Construct a circle of all impedances z_2' which can be transformed into z_3 by a line**

31. Impedance transformation - Reference Solution

$Z_0 = 50\Omega$



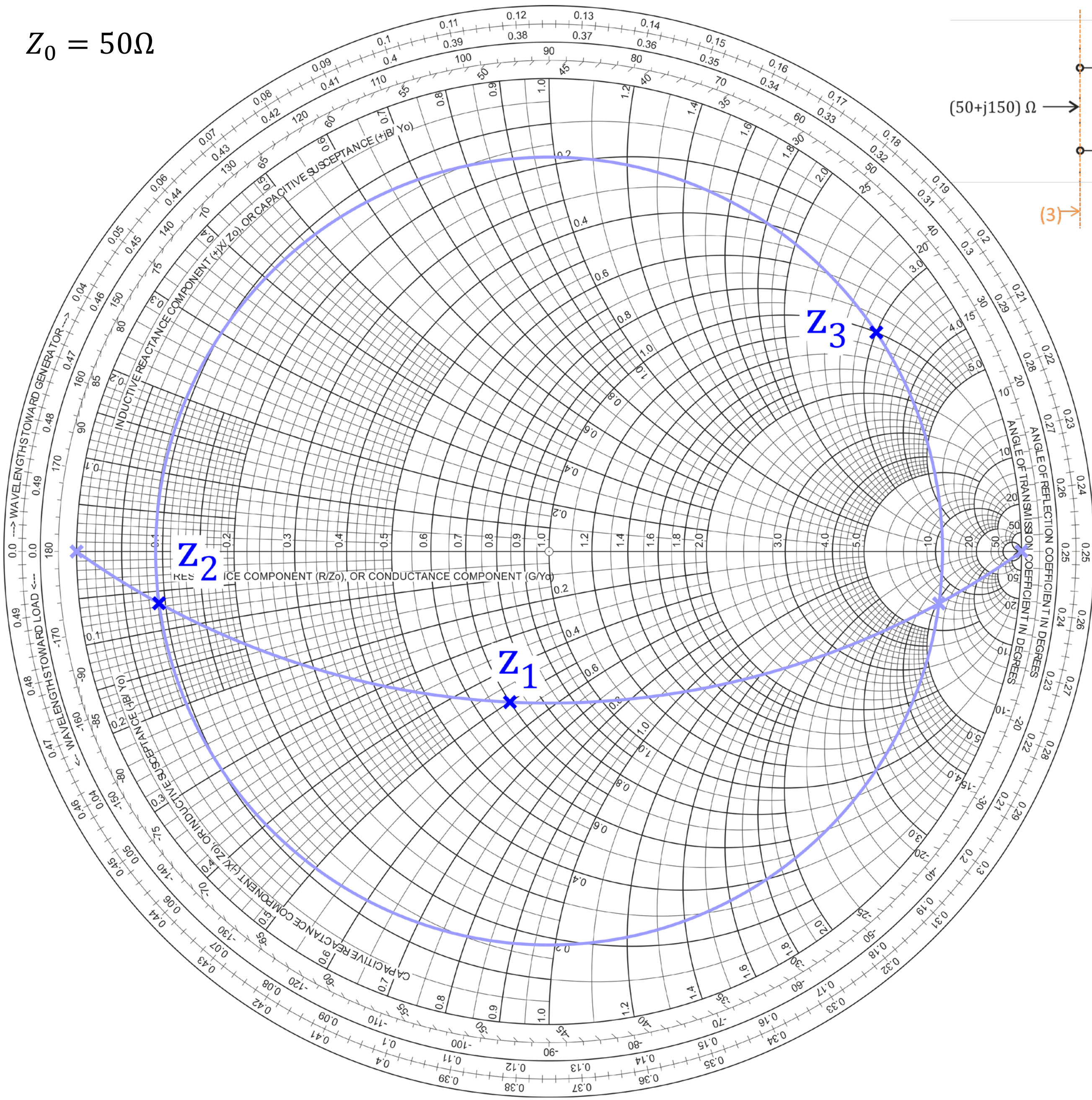


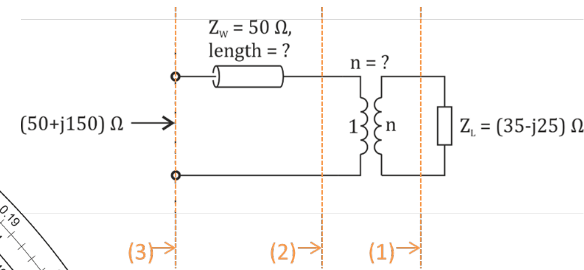
Solution:

- Enter three different values of $z_2 = \frac{z_1}{n^2}$
- Construct an arc connecting those three points
- Enter the targeted impedance $z_3 = 1 + j3$
- Construct a circle of all impedances $z_2{}'$ which can be transformed into z_3 by a line
- **Intersect the arc with the circle to find the two solutions $z_{2,A}$ and $z_{2,B}$**

31. Impedance transformation - Reference Solution

$Z_0 = 50\Omega$





Get the transformation ratio n:

- Select solution $z_{2,A}$ as it results in the shorter line length *(see next slide for line length)*
- **Read impedance $z_2 = 0.092 - j0.066$ and calculate**

$$n = \sqrt{\frac{z_1}{z_2}} = \underline{2.757}$$

Info: There is no need to do a complex valued division – it is enough to compare either real- or imaginary-parts!

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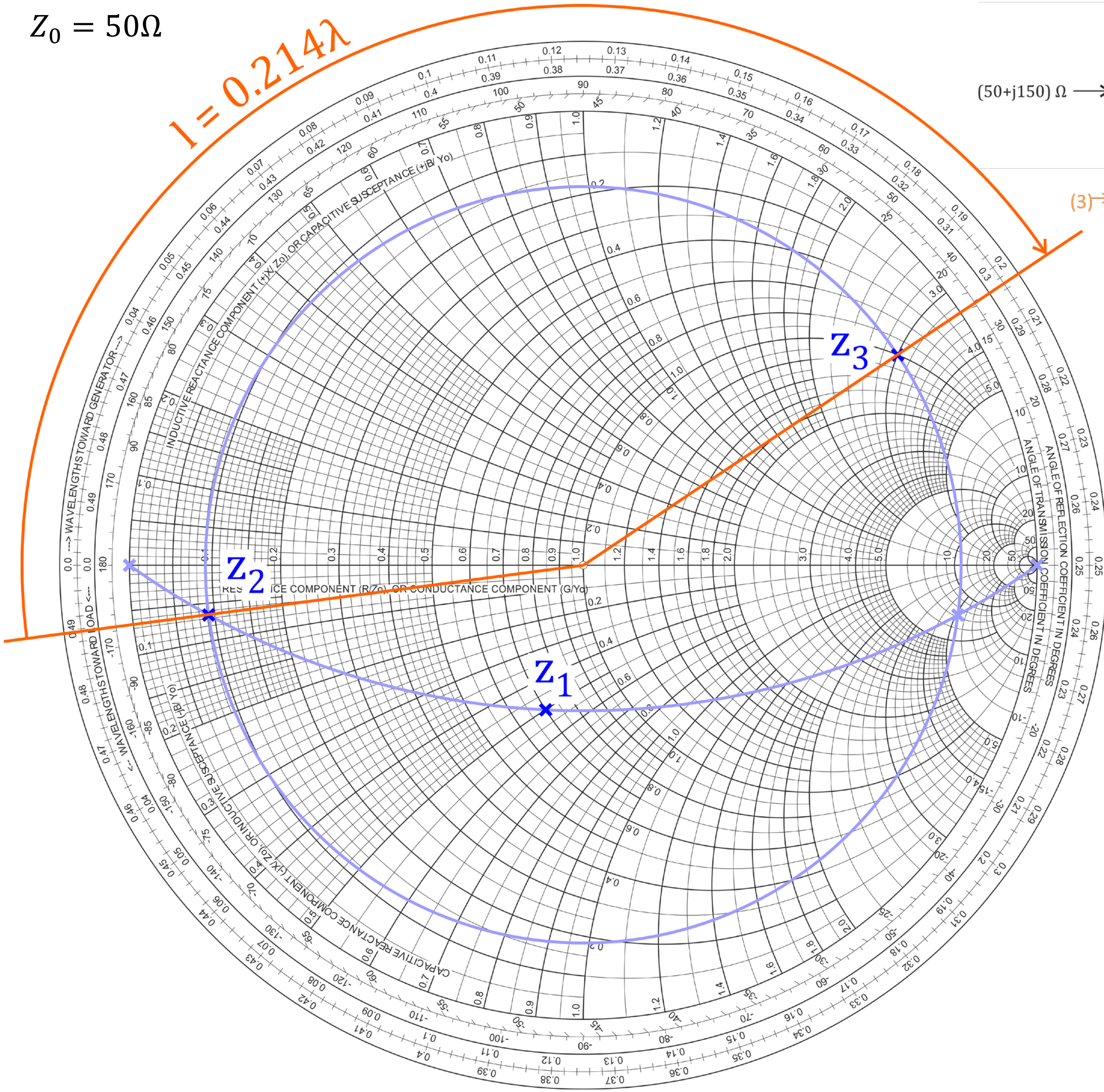
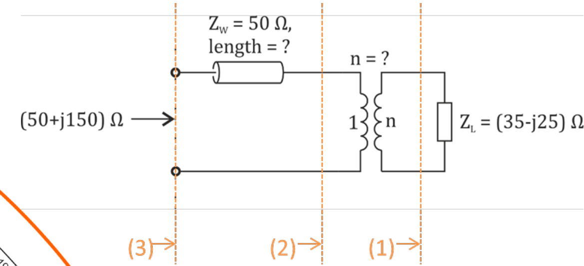
RF Techniques

31. Impedance transformation - Reference Solution

$Z_0 = 50\Omega$





Get the line length:

- **Determine the line length needed to transform z_2 to z_3 along the line towards the generator:**
  $l = \underline{0.214\lambda}$

That's it, you survived the tutorial!

<u>Questions?</u>

Assoc. Prof. Dr. Holger Arthaber
Email: holger.arthaber@tuwien.ac.at
Room: CF0131